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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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Specification and Workmanship equal to Main Line Locomotives.
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For Illustrated Advertisement, see page 6.

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See page 113. 6455

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See Advertisement page 119. 6462

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Destroyers, Torpedo Boats, Yachts and Fast Boats. 3809
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NORMAND'S Patent Water-tube Boilers, Coal or Oil Heating. Diesel Oil Engines.

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SYPHONIA STEAM TRAPS, REDUCING VALVES.
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See Full Page Advt., page 63, Jan. 10.

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See Full Page Advertisement Jan. 10.

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LOCOMOTIVE TRAVERSERS (ELECTRIC).

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Pott, Cassels & Williamson,
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See half-page Advertisement page 92, Dec. 27.

The Manchester Steam Users' ASSOCIATION.

For the Prevention of Steam Boiler Explosions and for the Attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. H. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 6661

UNIVERSITY OF LONDON.

Notice is Hereby Given that

the Senate will PROCEED to ELECT EXTERNAL EXAMINERS for the Examinations, other than Medical, above Matriculation.
(A) for the year 1919-20, as follows:—
In Geology: Mathematics: Physics.
(B) For the year 1919 as follows:—
One in Engineering (including Theory of Machines and of Structures, Strength of Materials, Surveying, Hydraulics and Theory of Heat Engines).
N.B.—Attention is drawn to the provision of Statute 124, whereby the Senate is required, if practicable, to appoint at least one Examiner who is not a Teacher of the University.
Particulars of the remuneration and duties can be obtained on application.
Candidates must send in their names to the External Registrar, Geo. F. GOODCHILD, M.A., B.Sc., with any attestation of their qualifications they may think desirable, on or before Wednesday, 29th January, 1919.
It is particularly desired by the Senate that no application of any kind be made to its individual Members.
If testimonials are submitted, three copies at least of each should be sent. Original testimonials should not be forwarded in any case. If more than one Examinership is applied for, a separate complete application, with copies of testimonials, if any, must be forwarded in respect of each. No special form of application is necessary.
University of London,
South Kensington, S.W. 7. R 869

UNIVERSITY OF BRISTOL.
DEMOBILISATION.

Special Regulations have been

made to allow intending students who have served in the war or in the scientific service of the war to be admitted to matriculation by vote of Senate on their educational qualifications, without formal examination; and also to allow of such students entering the University in January if candidates in Arts; in January, or between January and May, if candidates in Science, Medicine, Dental Surgery or Engineering; and if grounds be shown, counting their first year's attendance as though it had commenced in October. Engineering students in special cases may be allowed to count one whole year's attendance.
The Special Army Education Certificate qualifies for Matriculation.
Applications to the REGISTRAR. O 722

University of Manchester.

UNIVERSITY APPOINTMENTS BOARD.

The Appointments Board consists of members of the Council and Senate of the University and of co-opted members, representing important business interests in Manchester. GRADUATES of the University, especially those who have been released from the Forces and are now looking for permanent appointments, are INVITED to COMMUNICATE with the SECRETARY of the BOARD.
Employers who have vacancies for qualified engineers can be supplied with names of suitable candidates who are registered with the Board.
Address, THE SECRETARY,
Appointments Board, R 584
University of Manchester.

Inst. C.E., I. Mech. E., B.Sc.,

and all Engineering Examinations.—Mr. G. F. KNOWLES, B.Sc., Assoc. M. Inst. C.E., F.S.I., M.R.San.I., PREPARES CANDIDATES personally or by correspondence. Hundreds of successes. Courses may commence at any time.—39, Victoria St., Westminster, S.W. 7096

Engineering Special Classes.

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CITY OF BELFAST.

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The Corporation invite—

Tenders for the Manufacture,

DELIVERY and ERECTION in Belfast of the undermentioned PLANT, viz.:—
SECTION "G"—
(A) One 50 ton overhead travelling electric crane.
(B) One 5 ton overhead travelling hand crane.
(C) Two 3 ton travelling electric jib cranes.
SECTION "H"—
(A) Two 24-inch electrically driven centrifugal pumps.
(B) One 8-inch electrically driven centrifugal pump.
(C) One 3-inch electrically driven centrifugal pump.
SECTION "I"—
Five cast-iron water storage tanks.
Tenders will be considered for either of the main sections, or for either of the sub-sections of Section "G."
The Specifications and other particulars may be obtained on application either to Messrs. PEBBLES, CARDEW, SNELL & RIDER, 8, Queen Anne's Gate, Westminster, S.W. 1, or to Mr. T. W. BLOXAM, M.I.E.E., City Electrical Engineer, Belfast.
Tenders upon the presented forms, must be lodged in the Town Clerk's Office, City Hall, Belfast, not later than Monday, 24th February, 1919.
The lowest or any tender will not necessarily be accepted.
An official receipt must be obtained for every tender delivered by hand. Tenders sent by post must be registered.
R. MEYER,
Town Clerk.
R 854

OTAGO HARBOUR BOARD,
NEW ZEALAND.

BOILER FOR TUG.

The Otago Harbour Board, Dunedin, New Zealand, invites—

Tenders for a boiler or boilers

for the Tug "Dunedin." Firms desiring to submit Tenders may inspect plans at the office of, and obtain copies of the Specification and Conditions from the High Commissioner for the Dominion of New Zealand, London. Tenders, enclosed in a sealed envelope (registered), endorsed "Tender for Contract No. 456," and addressed to the Chairman of the Board, will be received at Dunedin up till noon on Thursday, April 10, 1919. The lowest or any tender not necessarily accepted.
W. J. BARDSLEY,
November 1, 1918. Secretary.
R 946

BARNSLEY NATIONAL SHELL FACTORY, No. 2,
SACKVILLE STREET, BARNSLEY.

The BOARD OF MANAGEMENT of the above Factory invite

Offers for the Purchase of

No. 2 NATIONAL SHELL FACTORY, situated in Sackville Street, Barnsley, as a Going Concern.
The Factory consists of two Main Buildings, one approximately 100 ft. square, the second, 100 ft. by 40 ft. The former is equipped with Hydraulic, Air Compressing, and Electric Power Plant, and at the present time contains full Plant for the manufacture of 4000 4·5 Shell per week, with Tool Room and Blacksmith's shop included, and the necessary Motors, Line shafting, &c.
The second Room is at present equipped as a Bond Room and Store, and is provided with a good concrete floor.
There are four additional large stone and brick buildings, at present used as a canteen, stores, joiner's shop, and power house, and good offices are attached to the Main Building.
The whole Factory is conveniently situated on a Freehold site, between one and a half and two acres in area, with access to Sackville Street, Fitzwilliam Street, Summer Lane, and Shambles Street, Barnsley.
Orders to view the Factory, and with particulars of lists of machinery and equipment may be obtained from the undersigned, to whom offers should be sent in not later than Thursday, 23rd January.
W. P. DONALD,
Chairman & Secretary.
January 9th, 1919. R 883

IN CONSEQUENCE OF COMPLETION OF WAR CONTRACT.

TO MACHINISTS, CONTRACTORS & OTHERS.

AYNHO PARK, NORTHANTS—(1 mile from Aynho, and 6 miles from Banbury, G.W.R., G.C.R., and L. & N.W.R.)

MILLER & ABBOTTS, Auctioneers, Banbury, are favoured with instructions from W. C. WIGHTMAN, Esq., Agent for SIR FAIRFAX CARTWRIGHT, to arrange for—

Sale by Tender an Important

COLLECTION of Powerful MACHINERY (5-and portable).
The Sale includes Oil and Petrol Engines from 5 to 28 horse power, Platform and Rack Saws, Benches, Planing Machine, Band and Circular Saws, and general accessories, fully described in the Inventory, to be obtained of the AUCTIONEERS, Banbury, Byfield & Bicester, or W. C. WIGHTMAN, Esq., Estate Office, Aynho, Banbury.
Tenders to be in the hands of the Auctioneers not later than Saturday, 25th January. R 890

MORECAMBE CORPORATION GAS DEPT.

Tenders are Invited for one

Three-ton Locomotive Shunting Crane, or alternatively one Five-ton Steam Locomotive Crane.
The Cranes to be to maker's standard designs and specifications, and a copy of same to be enclosed with the Tender. Early delivery is a consideration. Tenders endorsed "Crane" to be in the hands of the undersigned not later than the 27th inst.
The lowest or any Tender not necessarily accepted.
By Order,
R. HY. RUTHVEN,
Gas Works, Morecambe. R 964

EGYPTIAN STATE RAILWAYS.

SUPPLY OF STEEL SLEEPERS.

Enquiry is being made by

the Administration of the Egyptian State Railways from British firms for PRICES and DELIVERY for the SUPPLY of 500,000, say 30,000 tons PRESSED STEEL SLEEPERS and FASTENINGS—4 ft. 8½ in. gauge track.
Plans and Specifications can be obtained on application to Sir A. L. WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, S.W., by whom proposals will be received up to midday, 24th January.
Firms should state any special condition they wish to put forward.
Results of this enquiry will be considered by the Administration, but it does not follow that any order will necessarily be placed. R 937

APPOINTMENTS OPEN.

KENT EDUCATION COMMITTEE.

BRITH TECHNICAL INSTITUTE.
PRINCIPAL:—WILLIAM NEAGLE, B.Sc., A.M.I.M.E.

Required, Evening Teachers

for Physics, Heat Engines, and other Engineering Subjects.
Salary in accordance with the scale of the Kent Education Committee.
Please send full particulars as to qualifications, experience, etc., to the Principal, Technical Institute, Brith Road, Belvedere, or to—
ARTHUR E. FLUX,
Organising Secretary.
Education Office, R 935
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Belvedere, Kent.

A Large Firm of Engineers

in the Midlands, have an OPENING for a YOUTH of good education as premium pupil, the course to include both works and drawing office.—Address, 4390, Offices of ENGINEERING.

Resident Engineers are

WANTED at once, in Manchester and other large provincial districts, to represent a large firm manufacturing Lifting and Shifting Miscellanea. Drawing Office and general Engineering experience is essential. Selling experience is desirable. Applicants must state their career in full, age, salary required and when at liberty.—Address, R 796, Offices of ENGINEERING.

WOOLWICH POLYTECHNIC JUNIOR TECHNICAL SCHOOL FOR BOYS.
(Engineering Trades).

Wanted, Senior Master, well

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Assistant Master, with

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THE UNIVERSITY OF LEEDS.
Engineering Department.

Assistant Wanted for

TEACHING Graphics and Machine Drawing. For particulars apply to the SECRETARY. R 963

WOOLWICH POLYTECHNIC,
London, S.E. 18.

Applications Invited.—Head

of ENGINEERING DEPARTMENT. Commencing salary, £600, rising by increments of £25 to £800.—For further particulars, apply PRINCIPAL. S 14

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE.

Applications are invited for

the position of ENGINEERING LECTURER for day and evening classes. Salary according to scale (Maximum for Honours Graduate or equivalent £335).—Further particulars may be obtained from the PRINCIPAL, to whom applications should be sent before February 5th. S 24

Large Firm of Engineers,

manufacturing commercial motor vehicles, REQUIRE Head Cost CLERK with experience of up-to-date methods and systems.—Address, stating age, experience and salary required, R 438, Offices of ENGINEERING.

Wanted, First-class Engineer,

with experience in planning and progressing work, in modern engineering works in Glasgow. Must be thoroughly practical and capable of planning work in proper sequence of operation and be qualified to control the progress of work through the shops. Man accustomed to heavy internal combustion engines preferred. State age, experience and salary required, and when at liberty.—Address, in first instance, PLAN, WM. PORTEOUS & Co., Advertising Agents, Glasgow. R 548

Superintendent Required for

Heavy Machine Shop, engaged on Steel Castings, Forgings, and general work, in Glasgow district. Good man, able to control labour, initiate and operate up-to-date methods.—State fully, age, experience, and salary to "MACHINE SHOP," WM. PORTEOUS & Co., Advertising Agents, Glasgow. R 924

CORPORATION OF CALCUTTA.

Applications are Invited for

the Post of EXECUTIVE ENGINEER, Water Works, Calcutta. The salary of the appointment inclusive of all allowances (except motor car allowance) is Rs. 1,000 rising to Rs. 1,500 per month by annual increments of Rs. 50. The person appointed will be required to keep a motor car, for the upkeep of which the Corporation will pay him an allowance of Rs. 100 per month. The cost of a motor car will if desired, be advanced by the Corporation and recovered in monthly instalments spread over three years.
The appointment is subject to the Provident Fund, leave and other service rules of the Corporation and may be terminated at any time by six months' notice on either side. The Provident Fund contribution is 6¼ per cent. of the monthly salary and an equivalent amount is contributed by the Corporation and the fund accumulates at compound interest. The selected candidate will be required to devote his whole time to the duties of his office, and will not be allowed to take up any outside work. He must reside in Calcutta. He will be liable to removal during the term of his office for misconduct or neglect of, or incapacity for his duties. He will be required to submit to a medical examination before joining his appointment. The Corporation will pay his passage (1st class) from London to Calcutta, but he must refund the amount so paid, if he gives notice within two years from the date of taking up his appointment. He will be required to take up his appointment, about the 1st April, 1919, and will receive half pay for the period occupied by the journey.
(B) Preference will be given to candidates who are Members or Associate Members of the Institute of Civil Engineers or Graduates in Engineering of a University, and have had waterworks experience especially in regard to pumping machinery and modern methods of waste prevention.
(C) Candidates are to state their age and experience.
(D) Applications will be received in England up to the 7th February, 1919, by S. W. GOODE, Esq., I.C.S., Lundin Links, Fife, from whom any other information concerning the conditions of service, &c., may be obtained, or in Calcutta up to the 28th February, 1919, by the Secretary to the Calcutta Corporation, Municipal Office.
C. C. CHATTERJEE,
Secretary to the Corporation.
R 874

Metallurgist Required for

large Electrical Works in Midlands for laboratory work and shop troubles on material. Applicants must have had college training and experience on microstructures of steels and brasses. Apply, stating age, training, experience and salary required, to R 766, Offices of ENGINEERING.

The Wrexham and East

DENBIGHSHIRE WATER COMPANY are in WANT of an ASSISTANT ENGINEER with some experience of Waterworks Construction and management. Preference will be given to an ex-military or naval man.
Application, in writing, should state age, qualification, and experience.
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Address, stating fullest particulars, age, experience, salary expected, etc., etc., R 649, Offices of ENGINEERING.

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Engineering Works in Glasgow, First-class MAN, accustomed to testing heavy internal combustion engines. Must be thoroughly practical and capable of controlling men on the test bed. This is a good opening for a suitable man. State age, experience and salary required.—Address, COMBUSTION, WM. PORTEOUS & Co., Advertising Agents, Glasgow. R 549

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The following Positions are

OPEN for Good All-Round Men. Free second class Mail passage provided out and home. Five years' Agreements, and if renewed each man would receive six months' leave on half pay:—
SHOP FOREMAN.—Good general experience. Age 21 to 25. Salary, Rs. 300 per month first year to Rs. 450 last year.
DRAUGHTSMAN.—A thoroughly good man, to take charge of Drawing Office. Experienced in designing small craft and with general office experience. Salary, Rs. 400 per month, rising to Rs. 800.
MOULDER.—Age 25 to 30. Required to be well up in general Moulding work and thoroughly experienced in all modern methods of turning out iron castings. Will be wanted to supervise erection of New Foundry. Salary, Rs. 400 per month, rising to Rs. 500.
In addition to salary, they would share in any half-yearly bonus sanctioned by the Directors.
Apply, with full particulars, to
T. BERNARD HALL & JONES,
Consulting Engineers,
King's Court, Colmore Row,
Birmingham.
R 970

PORT OF BRISTOL.

The DOCKS COMMITTEE of the Corporation of the City of Bristol require the

Services of a Mechanical and

ELECTRICAL ENGINEER to act as Second Mechanical Assistant to their Chief Engineer. Salary about £350 per annum.
The immediate duties will be the supervision of the repairs and the working arrangements of the Hydraulic Power and Dock Pumping Stations and the Cold Storage Machinery. Also the distribution of gas, water and electricity (direct and alternating current).
Applicants should have a thorough training in both Mechanical and Electrical Engineering and should be well acquainted with the principle of coal purchase by calorific values and should also be familiar with the details of office routine.
Applicants are requested to state their age, training, previous employment, present position and present or most recent salary. As far as is possible applications should be sent in on printed forms to be obtained from the Chief Engineer.
Applications should be received by the Chief Engineer not later than Monday, 10th February, and should be accompanied by copies of three of the most recent testimonials.
The appointment will be held during the pleasure of the Docks Committee.
THOMAS A. PEACE, Chief Engineer.
Engineer's Office,
Avonmouth Dock.
7th January, 1919. R 818

Works Manager Required.

First-class man, one used to Lift trade preferred. London district.—Address, R 568, Offices of ENGINEERING.

Works Management.—

WANTED, for large Engineering Works in Manchester District, with wide variety of Manufactures, a first-class ENGINEER as Assistant Works Manager, must be thoroughly trained, experienced in Machine making rather than in Engine building, well up in organization and progress control, and in modern tooling practice. Good opening for first-rate man. State age, experience, salary required, and send copies of testimonials.—Address, R 731, Offices of ENGINEERING.

Foreman Engineer Wanted;

well up in repairs.—State wages, training and age to R 831, Offices of ENGINEERING.

Wanted, Engineer, Good

practical man with sound technical knowledge for lay-out and erection of Crushing plant. Applicant must be good draughtsman and have practical experience in erection. State age, references and salary required and when available.—Address, R 606, Offices of ENGINEERING.

ELECTRICAL CHANGES PRODUCED BY LIGHT.

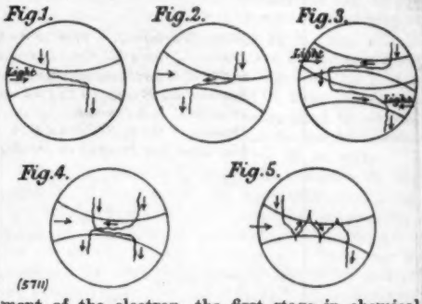
ON modern theories the subject of "Electrical Changes produced by Light," on which Dr. H. S. Allen, M.A., of King's College, lectured before the Röntgen Society on Tuesday the 7th inst., is one of the very widest a lecturer may choose. If all matter be built up of discrete electric charges, and light be an electromagnetic disturbance, then almost any change may be considered to be connected in some way with electricity, and with light. Even in the restricted sense of photoelectric changes, to which Dr. Allen confined himself, the subject comprises a vast range of phenomena.

Photoelectricity deals with the liberation of electrons by light, the term light signifying any radiation propagated at a velocity $v = \lambda \nu$, where λ is the wave length and ν the frequency of the vibration. The first photoelectric effect was observed by Hertz in 1887: ultraviolet light facilitates the passing of a spark between electrodes. The fundamental experiment of Hallwachs followed in 1888: ultraviolet light discharges a negatively charged body, but not a positive charge. Elster and Geitel, again a year later demonstrated that the electropositive metals, sodium, potassium and especially rubidium, are discharged even by visible light. When later Lenard and J. J. Thomson (1899) proved that the photoelectric current is, in a vacuum, carried by corpuscles or electrons, photoelectricity was properly put on its scientific basis. In demonstrating the effect Dr. Allen made use of an ordinary arc lamp, the ultraviolet rays of which chiefly come from the vapours between the carbons; the direct arc beam produced a slow discharge of a negatively-charged bright zinc plate; the discharge was accelerated when the rays from the vapours were (by a concave mirror) reflected upon the zinc, and still more when the carbon were further separated.

In the usual investigations of photoelectric effects, Dr. Allen explained, two methods are used: (1) either the positive potential P is determined which the plate assumes because the electrons e leave it at a velocity v, for the maximum of which $Pe = \frac{1}{2} mv^2$; or (2) a metal grid is interposed between the source and the plate, and the grid and plate are joined to the positive and negative terminals of a battery, the circuit including a galvanometer; in this case the current between grid and plate, *i.e.*, the number of electrons leaving the plate, is determined. When such experiments are made in a vacuum, the following relations hold: the number v and velocity of the electrons emitted are independent of the temperature, the number is directly proportional to the intensity of the light, their velocity independent of this intensity. In considering the influence of wave-length or frequency, the plane of polarisation has to be taken into account. Apart from this, the number of electrons increases with the frequency of the incident radiation ν and reaches a maximum for the frequency, such that $Pe = \frac{1}{2} mv^2 = h\nu - w_0 = h(\nu - \nu_0)$ [Einstein], where h is Planck's constant $6{\cdot}55 \times 10^{-27}$ erg per second, $w_0 = h\nu_0$, and ν_0 is characteristic of the particular metal, determining the amount of work necessary for any electron to escape from the metal. The constant potential between two metals, *e.g.*, depends upon the difference in their w_0. These fundamental equations of photoelectric activity possess a high degree of generality. With their aid Millikan (1916) obtained one of the best determinations of h, thus supporting the quantum theory, that the interchange of energy between matter and energy can only take place in indivisible quanta of the amount $h\nu$, and the equations seem to hold, Dr. Allen pointed out, not only for all light (including X-rays, O. W. Richardson), but also for the emission of radiation by the impact of electrons. The characteristic frequency for sodium is $\nu_0 = 5{\cdot}15 \times 10^{14}$. Light more red than this green radiation falling on sodium for centuries, will not produce any photoelectric effect whatever, whilst more violet light will at once produce it.

Passing to luminescence, the excitation of light by a stimulus other than heat, Dr. Allen referred to photoluminescence (distinguished as fluorescence and as phosphorescence, the latter indicating a glow which persists for a time after the excitation by light has ceased), electroluminescence, triboluminescence (produced by friction and illustrated by striking two quartz pebbles against one another when a reddish glow was seen) and chemical luminescence. In his demonstrations Dr. Allen showed that the reflected vapour arc produced a much more intense fluorescence or phosphorescences (of quinine, fluorescein, uranium glass, X-ray screens and of sulphides) than the arc beam itself, and that interposition of a red screen actually diminished a luminescence already excited. Many cases of these various kinds of luminescences were probably electrical in nature, and the law of Stokes, that the excited radiation is of larger wave-lengths than the existing radiation, was involved in the fundamental relation $\frac{1}{2} mv^2 = h(\nu - \nu_0)$; the law seemed natural when we supposed that the velocity with which an electron returned to a parent atom (which it caused to luminesce) was less than its velocity of emission.

As regards photochemical action and photography Dr. Allen took the view that the atoms of the molecules are held together by valency-electrons (the bonds of the chemist), that a chemical change must be preceded by a physical change, and that there is a commotion in the molecule before decomposition can take place (Chapman Jones). There must first be absorption of energy from a light source, leading to a separation or only a displacement of the electron, the first stage in chemical change being the ionisation of molecules. That condition of ionisation might persist for long periods, as in the case of suspended thermo luminescence, and Dr. Allen believes with Professor Joly that the latent image of the photographic plate is built up of ionised atoms upon which the chemical effects of the developer are subsequently directed. Complete chemical decomposition would not be required. The effects of radio-therapy were of a similar nature, the radiation stimulating or, if too intense, retarding and destroying the growth of living cells; this growth was certainly very sensitive to ionic concentration.



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Dr. Allen finally considered the phenomena of vision and of colour vision in particular from that point of view. No theory of colour vision was free from objections. The Young-Helmholtz theory, however, gave at least a simple representation of the facts of colour vision and colour blindness. According to that theory there were three elements of colour sensation, corresponding to three distinct physiological actions, one for each of the three primary colours, by the aid of which any colour could be matched. It was hardly necessary to assume with Helmholtz three distinct sets of nerves. It was frequently supposed that light entering the eye produced certain photochemical changes in the retina resulting in the sensation of light. Dr. Allen thinks it sufficient to assume photoelectrification of the substances in the rods and cones; that electrification would separate electrons in the nerve cells, and set up nervous impulses to the sensorium, and the changes in the retina would be identical in nature with those in a phosphorescent substance or in the photographic plate. The after-image (seen in the dark after looking at bright objects) would be a phosphorescence, the excitation of the retina being due to the separation of the electrons, the after-image to their return. In support of this view he referred to the production of light by electric stimulus or by sudden pressure on the eye; to the asserted visibility of Röntgen rays to dark-adapted eyes; to the curves of the sensitiveness of the eye to rays of different wave-lengths which resemble photoelectric curves for those wave-lengths (H. E. Ives); and to selective absorption and colour blindness. A pigment appeared red, because it absorbed (substracts) the green and blue rays from the white light received. A colour-blind man unable to see red resembled a man looking through green-blue ("minus red") spectacles. Dr. Allen in this connection showed some experiments due to C. R. Gibson, of Dublin. He had a set of silk skeins in rainbow colours. Illuminated by the arc beam passed through a screen of green-signal glass, these colours looked strange, of course, the yellow appearing green, *e.g.* When Gibson reproduced these colours on wool skeins, however, the hues appeared changed with the same green illumination; the yellow remained yellow, and that was, Dr. Allen said, because the yellow was really a phosphorescence colour. The point is scientifically and technically interesting; the dyes used were not specified. Whether this view of colour vision will satisfy physiologists, remains to be seen.

THE "N" OR FABRICATED VESSELS.

DURING the war practically every industry in the country has had its usual procedure revised, and in many cases modified to meet the exigencies which the circumstances of war produced. Shipbuilding, one of the most conservative of British industries, did not escape investigation for newer and simpler methods of accelerating output, and unquestionably the greatest departure in the practice of shipbuilding which has recently been introduced is the extensive adoption of the "straight-frame" system of construction.

In many of its features this system is not entirely new, but the absence of incentive in pre-war years to develop and adopt it, left a field of exploration which only required the exacting conditions of war to have it carefully and scientifically exploited. This was begun and carried out to a very large extent by Sir Eustace d'Eyncourt, K.C.B., Director of Naval Construction, Admiralty, and Mr. Thomas Graham, B.Sc., of the Royal Corps of Naval Constructors, Admiralty, who, in the early summer of 1917, got out designs on the "straight-frame" system, and embodying many other proposals for a simplified construction of ship intended to meet the growing demand for maintaining merchant tonnage.

The idea of the "d'Eyncourt-Graham" design was to build a ship whose transverse sections showed straight sides and bottom intersecting at a point forming an angular bilge, but at the same time retaining the orthodox shape of the waterplanes in a fore-and-aft direction, so that the ultimate features affecting resistance would not present anything likely to demand an increase of driving power. It was an interesting and important problem, and as a common practice has been to judge a ship by inspection of its body plan, anything so unconventional as an angular bilge appearing on the body was sure to raise anticipation of high resistance.

The designers contended, however, that the salient and determining feature in such a design was the trace of the "chine" line forward and aft, and a suitable adjustment of this chine at the ends would so accommodate the form to the stream-line theory that practically no extra power would be required in this form of ship as compared with an ordinary type. Indeed, where bilge keels are fitted in the latter, the straight-frame ship would, in a successful design, be capable of carrying for the same power a slightly greater displacement, a proportion of which could be rendered available for deadweight capacity. This contention has been fully corroborated by model experiment, and so surprising and consistent have the results of investigation been, that in view of the certainty of a good form, without surrendering any of the simplified construction which was the motive of the design, the Government adopted the type for their "National" (better known as "N-type") standard vessels.

The diagrams, Figs. 1 to 4, will help to illustrate the foregoing remarks: Fig. 1 illustrates a body plan of one type of straight-frame ship. This vessel is

400 ft. by 52 ft. by 31 ft. 0 in., identical as regards dimensions to the "A" and "B" types of standard vessels, and the horse-power performance of the model is better than that of the original forms of these vessels. This is due entirely to the careful adjustment of the chine line forward and aft, which is particularly good in this instance.

Fig. 2 is a body plan for the same vessel having the frame lines run down in each case to the rise of floor line, which in some respects would assist construction; but it is interesting to note that the resistance in this case is increased by over 50 per cent. as compared with the form shown in Fig. 1. Such a difference in resistance between the forms indicates the critical influence exercised by the chine.

Fig. 3 shows the original "N" type standard vessel form, the dimensions of which are 411 ft. 6 in. by 55 ft. 5½ in. by 38 ft. 1½ in. Slight readjustments of the disposition of buoyancy have been made since this form was designed, but in essential matters it has remained unaltered.

Generally speaking, it might be said that the straight-frame form, having an angular bilge, is from 2 per cent. to 3 per cent. more resistful than an ordinary naked form with rounded bilge, but as remarked above, when bilge keels are added slight advantage is transferred to the straight-frame ship, which does not have these appendages. It would follow, therefore, that if a straight-frame vessel be designed with a suitable chine, and then have the angular bilge rounded off, it should require no more horse-power than an ordinary vessel of exceptionally good form on the orthodox lines, while at the same time it provides a form entailing a construction very much more simple than that of the ordinary vessel.

Coming now to the general question of construction, Fig. 4 illustrates a midship section of the type as originally designed, and it will be noticed that here the bilge is absolutely angular. Needless to say, this prominent feature created a large amount of discussion, as some superintendents of shipping lines affirmed that the cost of maintenance would be increased. The designers, on the other hand, contended that from a purely structural point of view the angular bilge could be made stronger than the sheer-strake locality, and so long as the vessel were afloat, it was questionable whether this objection was not more apparent than real.

Exceptional circumstances, however, can never be too carefully anticipated, and although the design originally adopted by the Government for the "N" vessels preserved the angular bilge, this feature was subsequently chamfered off somewhat as shown in Fig. 5. These two structural diagrams convey a general conception of the simplified structure. There is neither bending of the frames, nor furnacing of bilge plates. The parallel middle body extends for half the vessel's length, over which length the structure remains practically unaltered. There is no sheer for this length, and hence the vessel's form is that of a rectangular box, which renders the members of construction simple and geometrically regular. The shell adapted to provide the necessary contribution to the moment of inertia of section is of uniform thickness from keel to sheer strake, and the frames in this neighbourhood being of equal length there is produced an "organisation of structure" which lends itself to very rapid erection.

Generally speaking, the construction of the ship, except for the unconventional features, follows the usual practice simplified by reason of form, but as this particular type has become associated with a

Fig. 1.

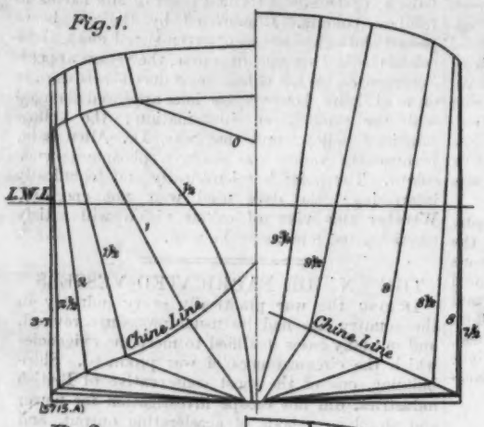


Fig. 2.

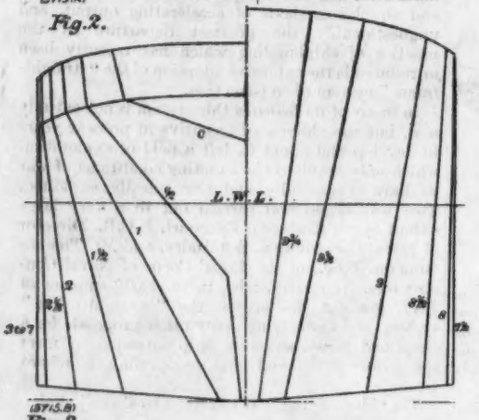


Fig. 3.

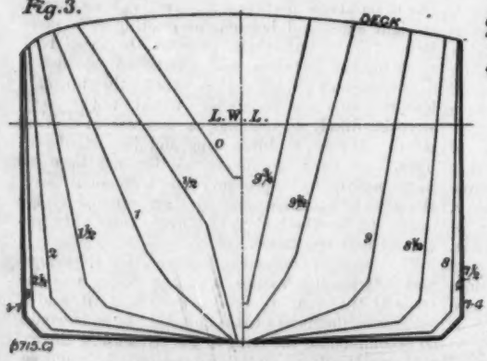


Fig. 4.

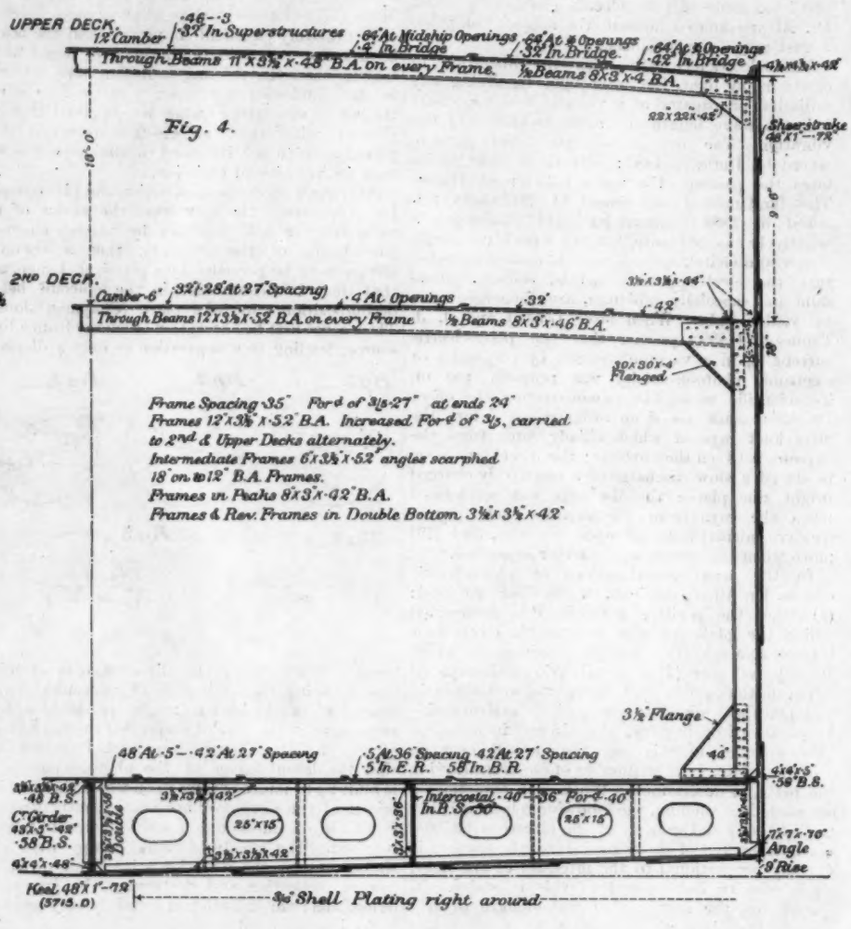

UPPER DECK.
Through Beams 11"X3½"X·48" B.A. on every Frame.
½Beams 8"X3"X·4 B.A.
2ND DECK.
Through Beams 12"X3½"X·52" B.A. on every Frame
½Beams 8"X3"X·46" B.A.
Frame Spacing 35" For'd of 3/5·27" at ends 24"
Frames 12"X3½"X·52" B.A. Increased For'd of 3/5, carried to 2nd & Upper Decks alternately.
Intermediate Frames 6"X3½"X·52" angles scarphed 18" on to 12" B.A. Frames.
Frames in Peaks 8"X3"X·42" B.A.
Frames & Rev. Frames in Double Bottom 3½"X3½"X·42"
3½" Flange
Keel 48"X1"-72"
(5715.D)
⅜" Shell Plating right around

Fig. 5.

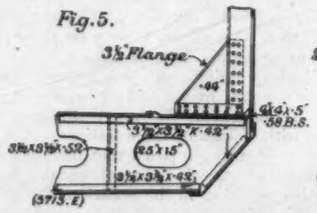
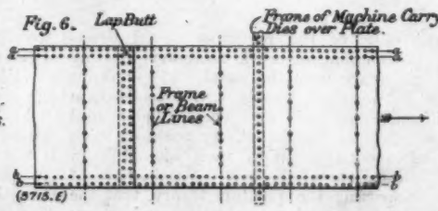


Fig. 6. Lap Butt



new process of construction termed "fabrication," the greater part of the remainder of this article may profitably be devoted to a description of this latest innovation.

Many people imagine that these "N" vessels are all "fabricated," but this is not the case. Until the "d'Eyncourt-Graham" system was introduced, fabrication was not a considered proposition; and now that this process of building has been introduced into establishments like the National Shipyards, it is important to state that "N" vessels were in the first instance built, and are still being built, in many of the great private shipbuilding yards throughout the country where all the material is prepared on the premises.

It is of interest to note in passing that the term "fabrication" is one which has been vested with two entirely different meanings amongst English-speaking people on both sides of the Atlantic. In America it has become an expression in scientific nomenclature implying a process of erection, whilst in this country it has usually been employed in unhappy association with that which is not genuine. Sir Eustace d'Eyncourt and Mr. Graham originally termed their design as one for an "assembled" ship, and it was only after the Government in this country had adopted the type and process, and were followed by the United States, that the latter country applied the term "fabrication" to the new process, and since then it has become the universal term employed. It is only the term, however, that is American; the actual idea and design are British. Fabrication simply implies a process of building up ships with parts which have been previously prepared at various centres throughout the country, and it was a natural result of centralised control for war purposes.

As the war became monthly and yearly more universal, and it became essential to utilise every source of industrial and engineering activity throughout the country, many inland structural and engineering establishments became available for assisting in the shipbuilding campaign, and although it was not seen at first how the services of these auxiliary workshops could be rendered useful in connection with shipbuilding, the appearance of this simplified design changed the outlook from a mere idea into a practical proposition. For instance, all the frames of a vessel could be cut and punched by the structural engineers in the Midlands, the plates could be rolled and punched at the steel mills, say, in Scotland, the making of the masts, engine and boiler casings, hatch coamings, girders and numerous other structural internals could be sub-contracted to large or small structural yards throughout the country, and all these various items on despatch to shipbuilding centres were simply ready for erection and riveting.

Similarly, in relation to engines, all firms could not make the large parts forming a reciprocating engine, but smaller establishments could be perpetually turning out turbine blades and other parts in connection with a rotary installation, and so the somewhat extraordinary conclusion was arrived at that ships and engines, with a multiplication of small parts which could be sub-contracted, lent themselves, under the circumstances, to rapid output.

It will be apparent that before such an organisation of assembling could be arranged and carried into effect, the ship's form and construction had to be investigated, as no other cargo ship's form and construction had ever been investigated before. Geometrical features which had hitherto been irregular had to become regular and simple, and parts which were various and component had to be unified, and the only possible conditions which could support such a process were simplicity and accuracy of detail.

In preparing the parts of the vessel for "fabrication" a prominent feature of the process was the punching of the main structure throughout the middle portion of the ship by means of the multiple punch.

This machine consists of a punch having a large number of dies which can be set at any desired distance apart in the transverse direction, and any of which can be knocked out of action as cases may require; at the same time the plate is carried through the machine in a series of uniform stages, so that the spacing of the holes in the longitudinal direction is also controlled. By temporarily knocking out all the dies, the spacing of the holes in a longitudinal direction can be increased when desired. It is to be understood that by the term "longitudinal direction" is meant the direction of travel of the plate through the punching machine. In arranging the process a "basis" figure of hole spacing is determined, say, 3½ in., and all the dies are set at this distance from each other, and if at intervals a wider spacing is desired, then intermediate dies can be suspended from action, leaving a spacing between the adjacent holes of 7 in.

In order to obtain the full benefit of the multiple punch the "organisation" of the ship structure must be of a comprehensive kind. Four features are particularly essential:—

1. The holes should be of the same size, which involves arranging for a common size of rivet, throughout the portion of the ship to be multiple punched.
2. The plates should be rectangular in form.
3. The breadth of the vessel must be a multiple of the basis figure of the punch.
4. The frame spacing must be a multiple of the basis figure of the punch.

Fig. 6 illustrates a deck or shell plate which has to be multiple punched. Suppose the size of rivet is ⅞ in., and the spacing four diameters, or 3½ in. apart, centre to centre in both directions, and the beam or frame rivets eight diameters or 7 in. apart, the length of the plate is determined by making it a convenient length multiple of 3½ in., say, 100 × 3½ in. = 29 ft. 2 in. + (1¼ in. × 2) for clearance between end rivet holes and edges of the plate; the total length is therefore 29 ft. 5 in. Similarly, the breadth of the plate is determined to accommodate the hole spacing in the beams or frames, say (9 × 7 in.) + (1¼ in. × 2) = 66 in. wide.

The plate travels through the machine in the direction of the arrow in Fig. 6, and the holes along the landing edges *a a* and *b b* of the plate are punched, while the intermediate dies between these lines are out of action. When a beam or frame line is reached, such of the intermediate dies as are desired are brought into action, and punch out in a single operation the necessary holes as shown. As the spacing of the holes in the beam or frame must also be a multiple of the basis figure, and as twice this figure throughout might be too wide an interval of spacing, a compromise is effected by having two adjacent holes 3½ in. apart and the next space 7 in., and so on alternately, making an average of six diameters apart (to employ the figures in the example taken).

It will be readily inferred from the foregoing brief description of the multiple punch process that great care in the office preparation of the work is called for, and every detail of the construction comes in for its own scrutiny as a component member of the whole ship. In this way, many details, such as beam knees, bulkhead stiffeners and brackets are considered more thoroughly in association with the main members of which they form a part, a feature which promotes a comprehensive perspective of the structure of the ship as a whole. Further, the repeated accuracy of the punching eliminates the probability of blind holes, and so dispenses with many of the objectionable "processes of correction" like "riming" and "drifting." The result has therefore been that the fabricated ship is a vessel of almost mathematical precision, which may in subsequent years set a distinct shipbuilding precedent, even amongst private owners.

So far, only the "N" vessels built with ordinary transverse framing have been dealt with in this article, but, as can be readily understood, the system of straight-frame construction lends itself to a simplification of vessels built on the longitudinal system, and the Government have recognised this by laying down a number of vessels of the latter kind, one or two of which are already at sea. Inside the parallel middle body the longitudinal construction does not vary very much from practices already known, except that there is no curvature in the floor plates, but at the ends of the vessel the benefit of the form becomes apparent in the widely-spaced transverse webs, the edges of which are, of course, straight lines. The longitudinal frames at the ends of the ship are curved to the contours of their respective water planes and, to some extent, that discounts the motive of the form. Clear of midships there is no object in maintaining high inertia of section, and Sir Eustace d'Eyncourt and Mr. Graham, in their original suggestion for vessels of this kind, have arranged for a combination of longitudinal and transverse framing. The intention here is to frame the middle body on any of the known systems of longitudinal construction, and clear of this neighbourhood forward and aft to revert to the ordinary transverse system whereby bending of frame members would be unnecessary. This would appear to be an economical arrangement, and one which exploits the usefulness of the form to its fullest possible extent.

With regard to the machinery of the fabricated vessels, the engines are geared turbines and the boilers of the water-tube type. As already stated, an installation of this kind lends itself to sub-contracting, which, during the war, was the best method of expediting delivery, but apart altogether from process, it is an installation which presents an interesting problem, and has probably a great future before it. Much has been written about the adoption of geared turbines for cargo boats, and the problem is not one associated with fabricated vessels only, and therefore need not be enlarged upon here. As regards the water-tube boilers, there can be little doubt that with experience, their adoption in the merchant service should prove a great asset in rendering more space in the vessels available for cargo carrying, and it is worth pointing out that many of the auxiliary craft in the Royal Navy which have been fitted with water-tube boilers have been manned by merchant ratings during the war, which will have probably gone a long way in disseminating familiarity in working the type.

At one time it was imagined that "N" vessels would be a war-time expedient only, but the careful attention which has been devoted to their design has probably rendered them a permanent type of cargo vessel. Unfortunately, no estimate of the cost of a fabricated vessel is available, but whether it be higher or lower than the cost of a vessel built in the ordinary way is no comparative criterion of value. Organisation and facility of resource are the only weapons with which to combat the abnormal costs due to the war, and in consequence with the lapse of time the fabricated vessel is bound to prove a cheaper vessel than what might be termed a "single effort" ship. As indicating the extent of the organisation already established for fabricating purposes, it may be mentioned that there are built, building and on order throughout the world vessels on the "d'Eyncourt-Graham" system of construction representing from 750,000 tons to about 1,000,000 tons of deadweight, an aggregate which clearly reflects increasing confidence in the type, and should help to mollify the conservatism in some home quarters where all innovations are viewed with suspicion.

TEMPLETS, JIGS AND FIXTURES. No. XVIII.

By JOSEPH HORNER.

IN preceding articles there is one feature which cannot fail to have attracted attention, the frequent repetition of some elemental forms which have always been familiar in connection with the general practice of the machine shop—methods of location, of setting, of attachment, of securing with fastenings of diverse kinds. The prototypes are old, the forms evolved therefrom and embodied in the later fixtures possess many refinements the purpose of which is the saving of precious moments, or the securing of closer degrees of accuracy. These elements have been illustrated only as integral portions of fixtures and jigs. It seems desirable now to make a digression to describe the typical forms of these older appliances which are strictly fixtures, but differ from those having that appellation in being employed directly on machine tables. They comprise large groups, families, or classes which have each common characteristics, and similar utilities. They are indispensable in the services

of the machine shops. They range from very simple to more elaborate forms and are used for general and for special work respectively, so special in some cases that they are only employed for the particular duty, or the very limited range of duties for which they are designed. Although these are commonly termed appliances, that of fixture would be more generally applicable.

These aids occupy their own particular sphere associated with that large volume of work for dealing with which the more elaborated separate fixture would either bear too high a ratio of cost, or would be too unwieldy to handle. They take charge of that large portion which is generally lined-off before it is put on the machine tables, on which it is set, and checked with surface gauges, indicators, calipers, and squares. Without these appliances much time would be wasted in setting-up and securing. The difference in the time occupied in setting varies with the degrees of refinement in measurement, and in the economies of motion studies that are woven into their designs. These helps should, for these reasons, not be excluded from an extended study of the wide field covered by the present subject.

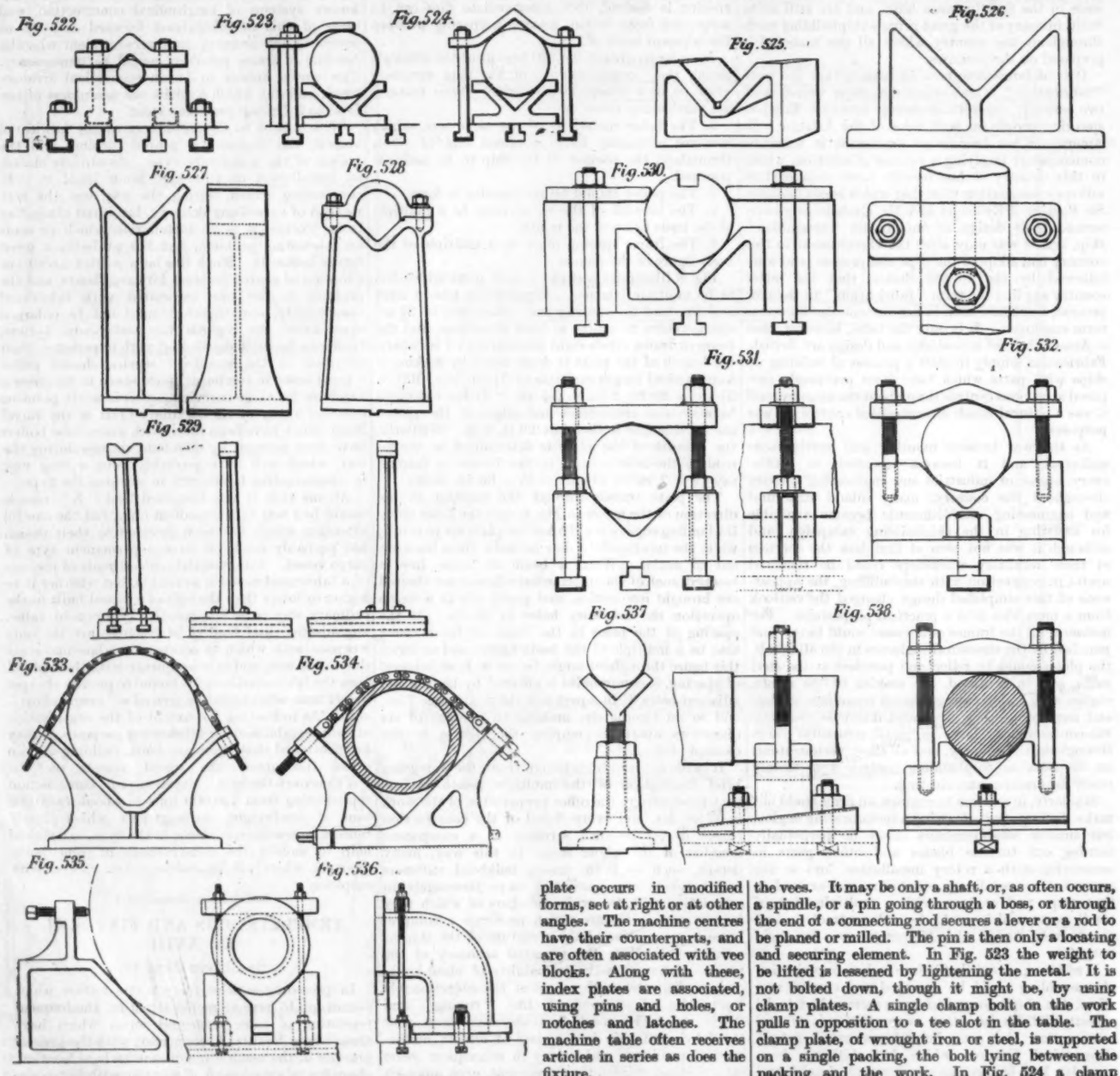
Ideas gathered from the practice of the machinist in attaching work directly to machine tables are prolific. Lining-off is often done in the case of massive articles in order to be sure about related parts "holding up" to dimensions. Loose packings, and loose bolts common on machine tables are transferred as permanent fittings to fixtures. Adjustments with setting-up screws are common in both. The vee blocks have their analogues in many vee-locating elements in fixtures. The angle plate occurs in modified forms, set at right or at other angles. The machine centres have their counterparts, and are often associated with vee blocks. Along with these, index plates are associated, using pins and holes, or notches and latches. The machine table often receives articles in series as does the fixture.

Naturally the cost of fixtures, though often high in consequence of their elaborated and accurate character, is a matter which must always be taken in its due perspective, that is, in its relation to the output. The appliances in common use are less costly, and they occupy, therefore, a place of medium utility and value. They may be of the simplest possible design for general service, ranging to those having restricted duties—fixtures absolutely.

A very large group is that occupied by the vee blocks. Ordinarily these are held down singly to the tables of machines to receive cylindrical pieces, as shafts and spindles that have to be planed, slot-drilled, milled, or drilled. But when numbers have to be handled a fixture is made, containing a series of vees, and including provision for clamping with rapidity. The fixture can be loaded on a bench and transferred to the machine. Other vee blocks include provisions for making adjustments of various kinds.

The common and standard forms of vee blocks are shown in the group of Figs. 522 to 526. In Fig. 522, the block is solid, and the clamp bolts that hold the work are independent of the bolts which secure the block to the table. A shaft is shown in the vees. It may be only a shaft, or, as often occurs, a spindle, or a pin going through a boss, or through the end of a connecting rod secures a lever or a rod to be planed or milled. The pin is then only a locating and securing element. In Fig. 523 the weight to be lifted is lessened by lightening the metal. It is not bolted down, though it might be, by using clamp plates. A single clamp bolt on the work pulls in opposition to a tee slot in the table. The clamp plate, of wrought iron or steel, is supported on a single packing, the bolt lying between the packing and the work. In Fig. 524 a clamp straddles over the work, and two bolts hold it down and no packings are required. In each of these figures the clamping plates are bent in order to lessen the lengths of the upstanding bolts, and so favour stability under cutting. Figs. 525 and 526 show two heavy designs of vee blocks lightened by coring. Although a single block will take a good range of diameters, yet a large stock is necessary to cover the requirements of a shop. Those shown are of cast-iron, but the smallest blocks are usually planed out of wrought iron or steel. All must be planed in the vees, and on the base, most are tooled on the sides also.

Examples of very tall blocks are shown in the next group, Figs. 527 to 529. These are used for



articles, portions of which stand out very far from the cylindrical sections that are laid in the vees, the deeper portions lying below the vees and clear of the table. Throw cranks are examples of this kind, and some forgings having long levers on their shafts. The castings are ribbed for necessary strength, but are not made any heavier than need be. Fig. 528 is provided with a cap instead of using loose clamp plates. In Fig. 529 a similar pair is shown, both of the same height. But very often one of a pair is made higher than its fellow to receive different diameters on a shaft or other forging, coming therefore within the range of special forms. Apart from this provision heights are increased by the insertion of loose packings made of angle sections. These tall blocks are provided with tongues to guide them steadily and in alignment along the machine tables.

More specialised forms are shown in the next groups. A block holding a large cylindrical piece of work is shown in Fig. 530. The method of bolting secures it, along with the shaft which it locates and carries, and it is one in very common use. The clamp plates bear by their bevelled and rounded ends on the work, and are supported horizontally on stock packings. The bolts pull the clamp plates down on the shaft. Low vee blocks are much more steady than tall ones in cases of this kind, since they take shorter bolts, and the packings are less liable to tilt. In Fig. 531 the vee block is bolted down independently of the clamping plate, which in this example is a bar bridged across, and having a very shallow vee of large angle to take a bearing on the shaft. The bolt holes are slotted clear out to the ends. The presence of the clamp plate bridging the work would prevent cutting along the whole length of the shaft, which can be done in Fig. 530. Fig. 532 shows another method of fixing where the block is held down with a bolt in a flange on one end, which is slightly more favourable to the resistance of heavy cutting than the other designs are. Here studs are tapped permanently into the block, and the clamp plate is cranked, providing a vee grip, and shortening the lengths of the stud bolts. In Figs. 531 and 532 the method of making the bolts and studs integral fittings with the blocks saves the time of looking up loose bolts.

Fig. 533 shows a large vee block holding a cylindrical piece of work, which is secured with a pitch chain lapped round it, and pulled taut with nuts on screws at the ends. The lengths of the screwed ends provide for a fair amount of accommodation for articles of different diameters.

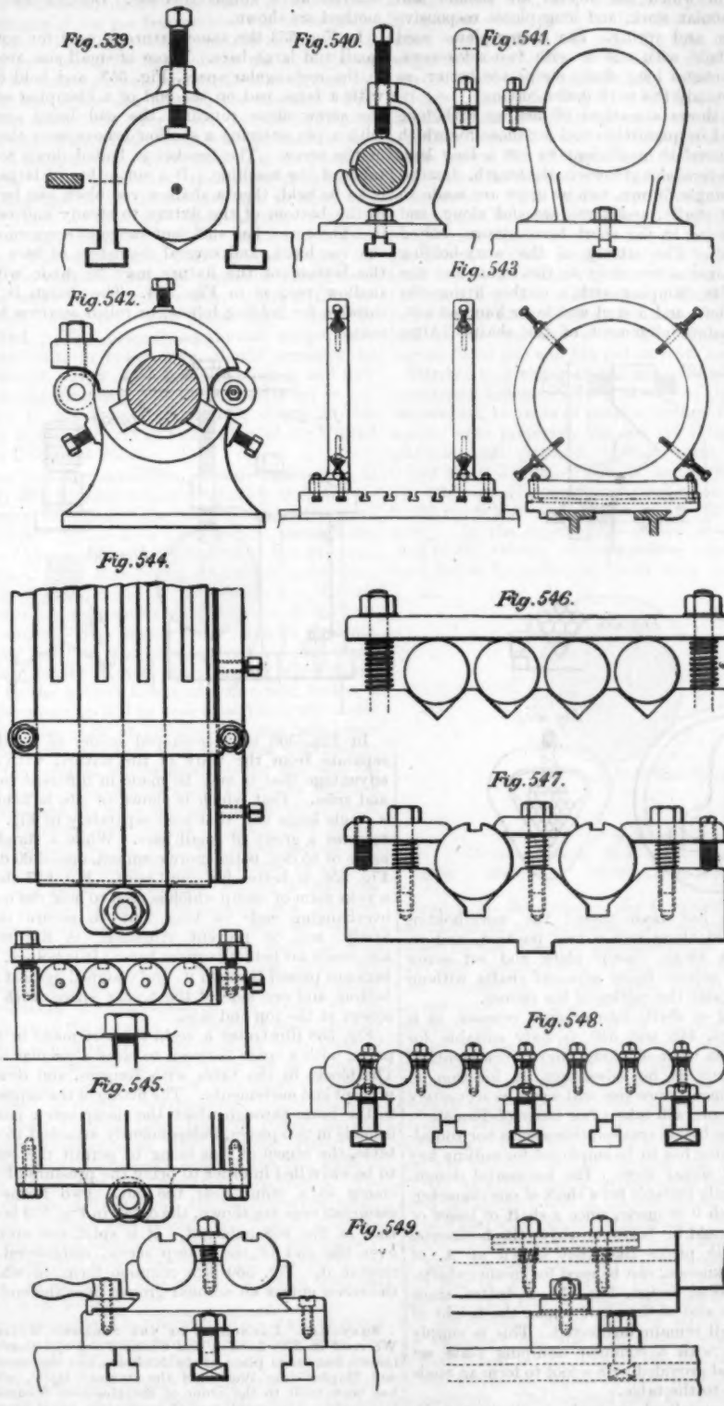
Considerable numbers of vee blocks are made with means of adjustment for varying heights, which is not necessary when the tools have provision for vertical accommodation, nor when the work-holding table can be raised and lowered. To effect this adjustment a block is made in two portions, Fig. 534, in which the left-hand sliding piece being moved towards or away from its fellow provides the desired accommodation for height. The loose half is fitted to the base of the other piece, sliding on it, and being moved with a screw. The chain fastening is identical with that in the previous figure.

Frequently the halves are made distinct and separate from each other, and are then set in their relations by hand adjustments, and so clamped down. An example of this kind is shown in Fig. 535, one half only being shown, the other is identical. Here a horizontal set screw grips the work, but this would not be secure enough for heavy service.

In Fig. 536 a divided block with a narrow face is shown locating a bend pipe by a flange. The vees are adjusted to suit the height of the flange or centre of the pipe, and are then bolted down to the table. In the right-hand view the lower flange is shown supported on packing which may be required to bring the centre to a definite height. The clamping of the bend is done in two localities. In one with two long bolts, and a plate near the vertical flange, in the other with short bolts and clamp plates on the back of the lower flange, and with supporting packings.

Rigid vee blocks—those the height of which cannot be varied, to suit shouldered shafts and castings, except by the insertion of packings—are not so satisfactory as are those where minute adjustments can be effected. Two examples of these are shown. In Fig. 537, the vee is provided with a stem that goes down into a base, and which is adjusted vertically by the turning of its nut. In a somewhat similar design a circular nut is used with tommy holes. It has a boss that enters into a hole in the top of the stand and which is prevented from coming out by the insertion of a pin in an annular groove in the boss. In another design a tapered base is employed, Fig. 538, along which the vee block is moved with a tongued fitting, and when set, is clamped down.

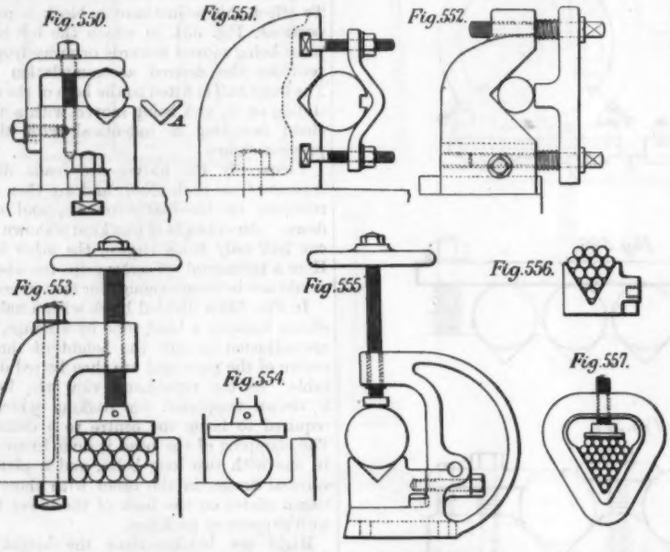
A good many work-holding fixtures for cylindrical pieces fulfil a function similar to that of vee blocks, although they are not exactly identical in outline, but differ therefrom in the fact that they lack the range of diameters that vee blocks will admit. They mark an advance in specialisation since they are made to admit a standard run of work, either of one dimension only, or of a very limited range. Allied to this is the practice of making a shallow vee groove, Fig. 539, in a machine table when long shafts are being regularly slot-drilled, or milled. The grooves are increased in number on tables when key-grooving is being constantly done. For work of this kind on large shafts a useful clamp is that shown in Fig. 539, being a bridle with tee-shaped ends entering the table grooves, and having a clamping screw in a boss above. A considerable range in diameters can be gripped in this fixture, but the height of the centres and of the tops of the shafts will vary with every difference in diameter.



To avoid this is the object of the fixture shown in Fig. 540, where loose bushings are bored to suit shafts of different sizes, and split. These, gripping the work all round, are not liable to bruise or mark polished surfaces, as vee blocks and clamps might do if carelessly employed.

The fixture in Fig. 541 is a heavy casting with split lugs, tightened with a bolt to receive belted cylinders and work of that kind of one diameter. But smaller sizes can be included by the insertion of bushes as in Fig. 540. A fixture for heavy work is shown in Fig. 542. It is also especially suitable for pieces that cannot be slipped in endwise due to the presence of flanges or collars. The cap is hinged for the insertion and removal of the work, which is gripped by the three pads made to be adjusted radially with set screws for small variations in diameters, and which alone bear on the work.

Large numbers of cylindrical articles of a light character are held in the type of fixture shown by Fig. 543. The heads are set at distances apart to suit the work. The screws that centre and grip have a considerable range of radial movement and are provided with lock nuts. This type is employed mostly for tubes.



For shafts and spindles that have to be key-grooved, or drilled in large numbers, fixtures are designed to hold them with less trouble than that involved in arranging and clamping them directly on tables of machines. Instead of using loose vee blocks and loose clamp plates and bolts, the fastenings are combined with work-holding bases apart from the tables.

Fig. 544 shows a fixture of this kind in which vees are not used. A stout baseplace with flanking flanges receives the shafts, which are located against the left-hand flange, and tightened against it with set screws in the right-hand, bearing against a loose clamping strip. They are held down with the clamp bar shown, or with more than one if the shafts are long. The bar is swung aside on one bolt, and is slotted at the other end to receive the bolt that clamps it on the shafts. The fixture is secured to the machine table with a bolt in a lug at each end, with an open slot. Long shafts may overhang the fixture if key-grooves are not cut in the over-hanging portions. Shafts of great length may be supported in two similar fixtures, so lessening weight. In Fig. 545 a stop plate is shown by means of which the ends of shafts are located, and which also offers resistance to a planing cut.

In Fig. 546, shafts are clamped down in vees in series with a single bar, as in Fig. 544. In Fig. 547, short clamps are used which leave the tops of the shafts free for the passage of cutting tools. The outer clamp plates necessary in this case have adjusting grub screws which serve as packings to their plates. Both in Figs. 546 and 547 coiled springs throw the clamp plates off the work when the nuts are released. The reason for cutting grooves in the bottoms of the vees in Fig. 547 is to afford clearances to feather keys or splines that have already been inserted in their shafts before the opposite sides are tooled.

Fig. 548 illustrates a fixture for dealing with eight slender shafts held in semi-circular recesses. Cases in which this method is preferable to vees are those in which the objects are slender and delicate, tubular work, and long pieces responsive to vibration and spring. The clamp plates used are short, held with one or with two set screws. For some articles long clamp strips are better, as serving to steady the work under cutting.

Fig. 549 shows a method of dealing with long shafts tooled in quantities, and for those for which the table travel is insufficient to cut a long key-groove, or several slot grooves in the length. Instead of using a single fixture, two or more are made to support the shafts, and these are slid along, and set and carried in the short bases shown, bolted to the table. The setting of the work-holding fixtures against a vee strip on the right, and the method of its clamping with a washer fitting the vee on the left, and a stud and lever-handled nut, ensures absolute alignment of the shafts. After one section has been tooled the work-holding section is slid along into a new position, and re-clamped. A single clamp plate and set screw with spring release holds adjacent shafts without interference with the cutting of the splines.

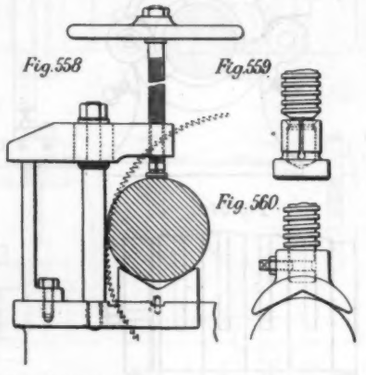
The fitting of shafts into concave recesses, as is done in Figs. 548 and 549, is only suitable for adoption when there is a long run of work identical in size. There is no advantage of location in their employment, since vees will centre as accurately and, in addition, will take a fair range of diameters.

Vertical vee blocks are desirable when a horizontal-spindle machine has to be employed for milling key grooves, and cottar ways. The horizontal design, Fig. 550, is only suitable for a shaft of one diameter. that for which it is made, since a shaft of lesser or larger size would lie below or above the horizontal centre. Angle pieces like that shown at A, of different thicknesses, can be used for smaller shafts. But the vertical design, Fig. 551, is better, since whatever the size of the shaft taken, the height of its centre will remain unaffected. This is simply a vee block with a common clamping plate set vertically, and provided with a foot to form an angle plate to bolt to the table.

A more specialised example is illustrated by Fig. 552. Here the clamping plate is double-sided, to be reversible. The rib on one side holds shafts of small diameters, as shown. When the plate is reversed the flat side takes its bearing on larger shafts. Springs throw the plate off on the release of the set screws. Another feature is that the vee block is adjustable along a base, to which it fits with vee'd edges. It is split, to be tightened on its base when set, with the set screw seen. This provision for horizontal movement is made in order to utilise it on a machine which has two horizontal spindles to cut on opposite sides of shafts.

A number of vee'd fixtures are employed in special connection with the power hack-sawing machines, and the cold circular saws. Large bars are cut off singly, those of small dimensions are grouped to be severed at a single traverse. Designs for each method are shown.

In Fig. 553 the same fixture is used for holding small and large bars. Those of small size are laid in the rectangular space, Fig. 553, and held down with a large pad on the end of a clamping screw, the screw alone rotating, the pad being secured with a pin entering a shallow groove near the end of the screw. The bracket is bolted down to the table of the machine. If a single bar of large size is to be held, then a shallow vee block can be laid in the bottom of the fixture to steady and centre it. The screw has sufficient range to accommodate the vee block, and several diameters of bars. Or the bottom of the fixture may be made with a shallow vee, as in Fig. 534. The design is also suitable for holding billets, or rolled sections to be sawn.



In Fig. 555 the vee-shaped holder is a fitting separate from the body of the fixture, with the advantage that it may be made in different forms and sizes. That which is shown *in situ* is holding a single large bar, that seen separately in Fig. 556 receives a group of small bars. While a standard angle of 45 deg. is the more common, one of 60 deg., Fig. 556, is better for small ones. Fig. 557 shows a yoke form of clamp which is used to hold the outer overhanging ends of long bars to secure them firmly, and to prevent vibration. A fixture is also made for holding square bars. It is hollow, the bars are passed through it, and clamped against the bottom and one side of the hollow space, with set screws at the top and side.

Fig. 558 illustrates a vee'd support made in two parts, with a space between to clear a circular saw. The blocks fit the table with tongues, and dowels prevent end movements. The fitting of the supports to the beam through which the clamp screw passes is made in two pieces, independently attached to the table, the object of this being to permit the beam to be swivelled in order to bring the pressure of the clamp to a point near the cut. Two forms of clamping caps are shown, the detail in Fig. 559 being that in Fig. 558 enlarged. It is split, and sprung over the end of the clamp screw, shouldered to receive it. Fig. 560 is a common form, in which the screw enters an annular groove near the end.

SHANGHAI: LAUNCHING OF THE STEAMER MYLIE.—We read in *The London and China Telegraph* that the launch has taken place at the Nicholas Tsu Engineering and Shipbuilding Works, of the steamer Mylie, which has been built to the order of the Haichow Steamship Company. The event was of more than usual interest as the Mylie is the largest ship ever built by Chinese builders. There is one of equal size on the stocks, the sister ship, the Gweneth. The Mylie is designed to carry a deadweight of 3,150 tons and will have a loaded displacement of 4,500 tons. Her length is 262 ft., 40 ft. beam, and 25 ft. moulded depth. The hull was made to the design of Mr. R. Simmons. The triple expansion engines of an indicated 1,300 h.p. developing a speed of 10 knots were designed by Mr. P. Reilly. The vessel has a cellular double bottom with fore and aft peak tanks capable of holding 400 tons water ballast. The vessel was built under the supervision of Mr. Bayes Davy.

MEASURING GAS TEMPERATURES IN BOILER SETTINGS.

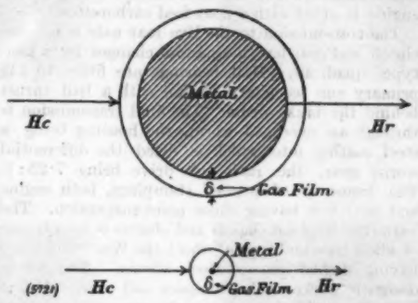
ENGINEERS do not generally trouble over much about temperatures in boiler settings. These temperatures, they know, may fluctuate considerably from moment to moment and from point to point, and the measurements are difficult and little reliable. An estimate of the gas temperature has to be made for evaporation tests. Such measurements would also be very useful for determining the advantages gained by making alterations in the setting, and by cleaning the tubes and blowing the soot off. But the determinations may lead to contradictory results when different thermometers are used in consecutive tests, or when their positions in the flues are changed. It is understood that most devices for indicating gas temperatures are apt to read too low. That a mercury thermometer, even if standardised, should be out by several hundred degrees Fahrenheit, and that thermocouples, for which the engineers have no particular liking, need not be more trustworthy either, would hardly be expected, however. But these facts must be admitted. Yet properly-conducted temperature measurements in boiler flues should certainly be encouraged. How the difficulties arise, and how proper measurements should be conducted is explained in detail in Bulletin 145, drawn up by Henry Kreisinger and J. F. Barkley, of the United States Bureau of Mines.

That all thermometers record incorrectly is mainly due to three causes—radiation from the instrument, variation of the temperature of the gases at different points in a cross-section through the path of the gases, and fluctuation of the gas temperature. The first factor, the most important, usually tends to make the records too low, the two others may cause errors on either side of the true temperature. The mercury thermometer does not quickly take up the temperatures of the gases rushing past it; in most cases—except when placed close to the hottest bricks of water-tube boilers—the thermometer will be near some relatively cooler surface, flue walls or boiler tubes, and will hence lose heat by radiation, and that loss will change with the position of the thermometer and will become larger as the temperature difference between the gases and the walls increases, and as the thermometer diameter and surface exposed grow larger. The exposed area is, both for thermometers and thermocouples, also an important factor, as we shall see; and when a protective sheath is used the sheath surface represents the exposed area. Thermocouples rapidly assume the temperature of the gas, but they are subject to the same losses of heat by radiation and conduction. These losses are smaller in general, however, and can be diminished by reducing the diameters of the wires (of the couple) or of the sheath. For wires of zero diameter the loss would be zero; by working with wires of different diameters the zero value can be deduced. The practical importance of this point—which is not novel, of course—is emphasised in the Bulletin.

In order to study these features, Kreisinger and Barkley experimented with various water-tube boilers, sometimes locally heating the flue walls in order to modify the radiation conditions. The boilers were of five types: Heine (two styles used), Parker, Babcock and Wilcox, and Stirling. In the two types first named the path of the hot gases is of U form, the flow being essentially parallel to the tubes; in the latter two styles the gases cross the tubes in an S curve.

Measurements of temperature were made at seven points, copper-constantin couples being used for temperatures below 500 deg. C., and platinum and platinum-rhodium couples for higher temperatures. Two couples of the same kind were clamped together to form twin-couples, the wires of one component of each twin being 0.008 in. in diameter at the hot junction, while the hot junction of the other component consisted of tubes approximately 0.5 in. in diameter. The leads of the small couples of both kinds were wires 0.025 in. in diameter insulated by porcelain tubes. The use of stout wires for the ends of thermocouples is, of course, unusual; the couples mentioned were especially prepared for experimental purposes, and the wires for the copper-constantin couple, finally recommended, have diameters of 0.024 in. It was found that the large couple of a pair always recorded lower values than the small couple, especially at high gas temperatures. Much depended upon the position, i.e., the nearness of tubes, drum and walls and baffles. In the Babcock-Wilcox boiler, *e.g.*, the smaller couple of the pair A, nearest the grate and below the nest of tubes, indicated 1,100 deg. C., and the larger couple 160 deg. lower; whilst the small couple B, near A but all surrounded by tubes, recorded 900 deg. C., and the large couple 230 deg. C. lower. In other cases the discrepancies were less striking, and there was an unmistakable general parallelity of the curves for the large and the small couples. Yet local and temporary fluctuations might be very pronounced. Thus the first-mentioned small couple A fluctuated between 1,050 deg. C. and 1,300 deg. C. (roughly) within 2 seconds—this is the worst case mentioned—whilst immediately afterwards the small couple C (within the nest) fluctuated only between 400 deg. C. and 450 deg. C. There is nothing surprising in these figures, of course; we need only look at our coal fires to see how changeable and narrow flame jets and hot gas currents are.

Further to investigate the remarkable and very unwelcome influence of the size (wire diameter) of the couples, two sets of couples, each of four instruments, were prepared, the one set being made of platinum and platinum-rhodium wires, diameters 0·450 in., 0·310 in., 0·024 in. and 0·008 in., and the other set of copper and constantan, diameters 0·550 in., 0·250 in., 0·024 in. and 0·005 in. respectively. In the experiments special attention was paid to the velocity of the gas flow, which, next to heat losses by radiation, is of very considerable



influence in determining the temperature that a thermocouple will indicate. The explanation suggested for the observed phenomenon is the following: The thermocouple is heated by the convection currents of the hot gases, and it loses heat by radiation; the possible heating of the thermo-junction by radiation, and its heating and cooling by conduction (along the wire leads) are disregarded by Kreisinger and Barkley. The heat imparted to the receiving instrument, they argue, depends upon the difference (a) between the temperature of the moving gases and the surface of the instrument, the velocity and density of the gases, and the exposed area of the receiving instrument, S; the radiation losses, on the other hand, depend upon the fourth power of the temperature difference (a) and also upon the exposed area S_1. The exposed area S for heat reception, now, is not the same area as that for heat radiation S_1, because there is a thin film of gas adhering to the wires or their sheath. This film increases the area of S, so that the gas particles really strike a larger body than we suppose; but the film is inessential for the radiation and for S_1, because the film is permeable to the radiation, whilst it does not itself radiate appreciably. The exposed area in both cases is a cylindrical surface and proportional to the diameter; but it is easy to recognise that, with decreasing diameter, S_1 will decrease much more rapidly than S. Hence the radiation losses from a thin wire are very small, and the small couple is more likely to record the true temperature of the gas surrounding it than a stout wire couple. The annexed diagram will help to make this clear; H_c is the heat imparted to the wire by convection, H_r the heat lost by radiation, δ the thickness of the gas film. As the diameter of the wire decreases the loss of heat by radiation diminishes, first slowly, then rapidly, and from their quantitative observations Kreisinger and Barkley conclude that the gas film thickness S amounts to about 1 mm. That sounds a very high estimate. But they do not mean the film of gas which is supposed to adhere to most surfaces in a layer probably of the thickness of not more than a few molecules. When a gas current passes through a tube, the gas velocity is fairly uniform in the central portion of the tube, but the velocity drops to zero close to the wall. Most of that velocity drop is confined to a layer of, say, $\frac{1}{4}$ in. thickness next to the internal wall. That is the film Kreisinger and Barkley think of, and they show, by measurements conducted with very thin thermocouples, that the temperature gradient across a boiler tube 2$\frac{3}{4}$ in. internal diameter, through which hot gases are sent at a speed of 108 ft. per second, is very similar to the velocity gradient determined by the aid of Pitot tubes. Some points of their argument may, perhaps, not be fully sustained; but thin-wire thermocouples certainly seem to be the best instruments for determining the temperatures of the gases in boiler settings. Inexpensive copper-constantan couples can be used for temperatures up to 500 deg. C.: in connection with portable potentiometers, which, though not inexpensive, are relatively strong, independent of the length of leads, and dispense with the need of high-resistance galvanometers which would otherwise be wanted. The Bulletin gives valuable practical information as to the construction, calibration, and manipulation of these instruments.

THE OPTICAL SOCIETY.

A MEETING of the Optical Society was held at the Imperial College of Science and Technology, South Kensington, on Thursday, January 9, 1919, Professor F. J. Cheshire, C.B.E., in the chair. A paper on the "*Design and Inspection of Certain Optical Munitions of War*" was presented by Lieutenant-Colonel Williams, R.A.

Lieutenant-Colonel Williams, who belongs to the Inspection Department at Woolwich, and is responsible for the inspection of most optical stores other than those used by the Royal Navy, and the Royal Air Force, said that he hoped that his paper might be of use in bringing manufacturers and others into closer touch with his department. Having explained the difficulties met with in obtaining the most suitable designs for service instruments, which must be much more robust than those used by civilians and have certain parts interchangeable, he made a few remarks upon service specifications and drawings.

He then described in detail how some of the more important tests are carried out. As regards optical systems: The definition is tested by means of plates having round and square holes and radiating grooves cut in them; the magnification by means of a dynameter; the field view and spacing of graticules by means of scales; the normal focus by means of an auxiliary telescope; the diopter scales by means of standard lenses, &c. He remarked that much trouble had been experienced due to lenses, prisms, &c., in enclosed instruments having become filmy after a time; but that the subject was too large a one to enter into upon this occasion. The testing of binoculars was then explained, and three instruments used for this purpose were described. The tests for such instruments as directors, No. 7, dial sights and clinometers were then described, details of some of the testing instruments being explained.

Defects which are sometimes met with were then mentioned; and it was suggested that research by the newly-formed British Optical Instrument Manufacturers Association should be of the greatest value to manufacturers and to the Inspection Department. He paid a tribute to the British optical industry for the way in which they had been able to supply the enormous number of instruments required for the war, without lowering the standard of quality.

Some very excellent lantern slides which had been prepared by Mr. Morrison, of the Optical Munitions Branch of the Ministry, were shown. The paper was discussed by Dr. R. A. Sampson, Astronomer Royal for Scotland; Mr. S. W. Morrison, of the Optical Munitions Department; Mr. R. S. Whipple, M.A.; Mr. T. Smith, Mr. H. A. Hughes, Instructor-Commander T. Y. Baker, R.N., Mr. H. F. Purser, Mr. T. F. Connolly, Mr. Williams, and Professor F. J. Cheshire.

THE INDUSTRIAL RECONSTRUCTION COUNCIL.—The second lecture of the series arranged by the Industrial Reconstruction Council will be held in the Saddlers' Hall, Cheapside, E.C.2, on Wednesday, the 22nd inst. The chair will be taken at 4.30 by the Rt. Hon. Lord Balfour of Burleigh, K.T., and a lecture on "Industrial Reconstruction in Government Departments" will be delivered by His Honour Judge Edward Parry. Applications for tickets should be made to the secretary, Industrial Reconstruction Council, 2 and 4, Tudor-street, E.C.4.

MESSRS. THORNYCROFT'S BASINGSTOKE WORKS.

AMONG the names which maintain the prestige of engineering effort in this country, few are better known than that of Thornycroft. The work done by Sir John Isaac Thornycroft in the first instance, and later by the firm, in the development of lighter naval craft of distinctive type needs no introduction. The original torpedo boat, as well as the modern destroyers and torpedo craft, owe much to the enterprise and workmanship of this firm. During the war their whole production has been exclusively in the national interest; but for well-known reasons their intensive activity has, of necessity, been secret. Their work in connection with the new mosquito fleet, for example, is by no means generally known or understood. The latest type destroyer, or leader, has nearly the horse-power of an early Dreadnought (40,000) with the advantage of vastly greater mobility due to greater speed; and as she mounts several 4.7 guns, she is virtually a cruiser.

The firm commenced the construction of motor cars at Chiswick, but since 1898 they have had a separate branch works at Basingstoke devoted entirely to mechanically-propelled road vehicles; they were among the first to realise the coming importance of the new locomotion. The progress of this side of the business has been steady and continuous, and their product is well known in the motor world. Illustrations of various parts of the works are given on pages 77, 78 and 84.

Now that hostilities are happily ended, and the grip of the Censor relaxed, it is possible to notice publicly some of the war activities of Basingstoke which have had a share in achieving victory. The site at Basingstoke stands geographically at the bifurcation of the main roads from London to Salisbury and Winchester, and was selected for this reason among many others. It has proved a convenient centre, both for London and Southampton, at which latter town are the main marine works of the firm. The earliest vehicles were steam-propelled, the firm winning War Office premiums for these and paraffin vehicles. The Somali steam wagon has long since yielded place to petrol lorries of standard type, and commercial vehicles are now the legitimate business at Basingstoke. Upon these the firm specialise, and they are to be seen on nearly every highway.

When the war began, the firm were among the first to place their entire resources at the disposal of the State, and during the period of hostilities their entire output has been absorbed by military and naval requirements. The war production at Basingstoke has taken three directions: (*a*) standard motor lorries for the War Office; (*b*) complete sets of engines and propelling machinery for coastal motor boats; (*c*) bomb throwers and trench mortars. The only variant has been an adaptation of the War Office lorry for Indian transport to the requirements of Lord Montague.

Upwards of 5,000 War Office lorries have been delivered, as well as over 100 Indian vehicles; 160 sets of C.M.B. machinery—engines, shafts, propellers and accessories—the hulls being made at Southampton; 3,000 bomb throwers of the larger sizes have also been made. One of the main factors limiting submarine activity and contributing largely to the eventual freedom of the seas, was the coastal motor boat. The combination of 40-knot speed, shallow draft, and depth charges, proved in the long run to be the real defensive arm against the underwater vessel. In the evolution of this type, Messrs. Thornycrofts deserve a large share of credit.

Illustrative of what can be done with small, well-designed craft, a Thornycroft C.M.B., drawing 30 in. of water, with two 150-h.p. oil engines traversed the high seas under her own power to the Tigris. It is also stated that her escorting craft found no small difficulty in keeping pace with her, owing to the fine turn of speed developed in the tiny craft. Engines of identical design, fitted as the motive power for rail locomotives, were used close up to the front line in France for haulage, low visibility being essential.

Large recent extensions have been made to the works, evident to those familiar with their pre-war appearance, and in many respects they are now of model character. Every production factory in the engineering trade has some problems varied by the exact product made which conditions the lay-out and general design. In particular, the production of motor vehicles lends itself to the employment of specialised methods, and is an oft-quoted and outstanding instance, wherein standardisation, specialisation and intensified production methods find a unique field. Road transport is itself dependent upon the co-operation of road authority and vehicle maker; the better the King's highway, the greater the volume of road borne traffic which benefits not merely the manufacturer but, for well-known economic reasons, the community at large.

The standard type lorry upon which exclusive effort has been concentrated during the war is typical of the firm's product. Altogether, four chassis represent the normal variety, but three differ in detail only.

The engine has four-cylinders in pairs, 114 by 152 mm. (4½ in. by 6 in.), developing 40 h.p. The valves are arranged on opposite sides of the cylinder head, inlets and exhausts being of the same size and interchangeable. The valves are accessible through a bayonet-jointed cover. The camshafts are driven by single helical cut gears from the crankshaft. The gear on the inlet camshaft forms the spider for the governor, which is totally enclosed in the crank case. The magneto is actuated by a third shaft parallel to the crank and camshafts, and is operated by a single helical pinion, gearing with the exhaust camshaft wheel. The fan and the circulating pump are belt-driven from a pulley on the magneto-driving shaft. The crank shaft has the usual three bearings, and the water circulating pipes are large enough for thermo-syphon cooling. A rotary pump provides forced lubrication to the crank shaft bearings. The engine is fitted with a float-feed carburettor.

The transmission to the live rear axle is by cone clutch and gear box, giving four changes by a gate type quadrant. Ball bearings are fitted to the primary and secondary shafts, with a ball thrust behind the brake drum. The final transmission is through an overhead worm, the housing being a steel casting into which is fitted the differential worm gear, the ratio of drive being 7·25: 1. The frame is of pressed stampings, both engine and gear box having three point suspension. The variation between chassis and chassis is largely one of wheel base and type of wheel, the War Office lorry having dished pressed-steel wheels. The whole design is workmanlike, compact and serviceable, it contains no freak features; the strength and construction have been proved by satisfactory service under the severe conditions operating during the war.

The outstanding features in the lay-out of the works are, a water tank tower, the lower portion of which is a central power house, and a very large open space which runs almost the entire length of the site, and divides the works proper from the offices and running sheds.

A pair of Sulzer 4-cylinder Diesel engines, each of 270 h.p. running at 187 revs. with air compression of 700 lbs. per sq. in., using tar oil as fuel, have been installed, and preparations are being made for a third set. The only disadvantage of the fuel, to offset its low cost, is piston trouble, otherwise the engines have given satisfaction and filled expectation. A modern Bowser oil and petrol storage plant, with eleven measuring pumps located together, is adjacent to the running sheds. The petrol tanks are completely buried, while other oils and lubricants are in an underground chamber and are accessible. A gantry, where test load boxes are stored at lorry-floor level—every chassis is tested under road conditions—is another noticeable feature near by. The pickling of castings on a large scale before machining is in evidence, as well as shot blasting for dressing case-hardened gears and brazing spelter.

A rather unusual blacksmith's shop displays a curious combination of diverse activity. In addition to regular forging, brazing and fusion welding—with electric metal electrodes and with gas—and die casting of bearings in Hoyt metal, find also a location; as well as a battery of Herbert hacksaws. An assortment of this character in one shop attracts notice. The brazing is done on simple hearths by gas, and the special job is the angle collars for the tubular frame stays. Die casting for white metal bearings for motor work is by reason of the quantities involved, an ideal process.

The case-hardening department (see page 77) is well equipped. The gas process is used and a sawdust producer plant, which gets the whole of its fuel from the body-building department, provides the gas. The Cambridge Scientific Company's electric recording pyrometers control the furnaces and every charge contains a pilot specimen subsequently broken to show the depth of the case. Five hours at 900/950 deg. is the usual time taken to give a case one-thirty-second inch thick. Nickel steel is also treated, and the specimen pilots show first-rate results of the methods employed. Here, as elsewhere, the treatment of great quantities of identical pieces serves to establish very close approximation and identity of result.

Machining in general is arranged by grouping either by product or machine (see page 78). The batteries of drilling machines include Asquith radials and Pratt and Whitney multiple machines. The advantages of multiple drilling to definite lay-out are very marked on crank cases for example. The gear-cutting section is particularly good, having groups of nearly all types of machines. There are Fellows gear shapers generating single helical gears, as well as simpler tools. The cutting of spur gears with formed cutters, and hobbing are all in evidence.

Automatics and capstans, by Ward, Potter and Johnson and Acme, bulk very largely, while in the cylinder section slab milling is well to the fore. Boring is done with the job in normal position, with undertype quadruplex boring heads, a process which has manifest advantages, although the operation of the tool is hidden from view. Grinding of cylinder bores is done on Heald internal grinders with special fixtures. These undertype boring machines deserve special notice. The machine itself consists of a large box casting fitted with doors, all the mechanism being internal. The top surface forms a plain machined table, and a simple bridge clamp holds the cylinder casting, located by its spigot, on to the entablature. Four boring spindles project upwards, driven from their lower ends by worm wheels, one worm spindle being extended for pulley drive at the side of the main casting at the bottom. The pair of worm spindles are geared to run together and the boring heads all run the same hand. The whole of the gearing runs in an oil bath, and the feed is given by an internal counter-weighted carriage and vertical feed screw driven through bevel gears by an external stepped belt pulley. By reason of the absolute total enclosure of all the mechanism, the machine contrasts with adjacent tools, while the chip removal presents no difficulty. An angle chute incorporated in the design, through which the spindles pass, prevents the chips reaching the interior mechanism. Virtually, the entire machine is a jig, itself unadaptable to any other job, and is illustrative of modern manufacturing methods, which evolve special machines for single jobs.

Owing to timber restrictions, large seasoning sheds have been recently erected, and a drying plant, shortly to be installed, will make this a permanent feature of the works.

Before a batch of engines are assembled, the whole of the details pass into store and get grouped together; while incomplete, a coloured slip indicates in each case the missing details. The complete set then passes to the erector, who is credited with the issue. Very large engine-erecting and chassis-assembling shops of modern type have been built, and a well-equipped view room in process of extension, through which all details pass for gauging and inspection, exercises a check upon the product, while very large stock racks for bar material are a necessary adjunct well in sight. The views shown on page 77 give some idea of the interior of the shops, which are lofty and well lit, and the cleanliness, and modernity and method everywhere evident are very striking.

Among other present activities at Basingstoke mention must be made of the overhaul of lorries returned from France for repair. Some of these

THE BASINGSTOKE WORKS OF MESSRS. JOHN I. THORNYCROFT AND COMPANY, LIMITED.

FIG. 1. CHASSIS AND BODY FITTING SHOP.

FIG. 2. ENGINE AND CHASSIS FITTING SHOP.

FIG. 3. CHASSIS ERECTING SHOP.

FIG. 4. CASE HARDENING FURNACES.

involve general overhaul of a more or less normal character, while re-conditioning in other cases is nearly re-construction. Quantities of such work are in progress, and will serve to bridge the transformation period between war and peace production. It is officially intended that the disposal of accumulated transport vehicles shall only take place when they are in good running order, and the return of salvaged lorries to their own makers for putting in order will afford an assurance to intending buyers.

Mention must also be made of the testing of vehicle engines with coal gas, a new departure due to restricted petrol supplies, and one which has certain advantages and conveniences, which may make it permanent. At all events the accumulation of grease and dirt which seems the normal condition of an internal-combustion engine test department is absent, while the road tests naturally precede the final acceptance. No reference to the works would be adequate which did not refer to the very complete laboratory facilities for reception tests of material (Figs. 6, and 9). A 50-ton Buckton tester, a spring-testing machine, photographic facilities and microstructure apparatus serve to exercise a check upon the quality and suitability of material supplies. There is no foundry at Basingstoke, but otherwise the works are complete from first to last. The first-rate and up-to-date canteen (Fig. 5, annexed), is liberally furnished with appliances, and forms a social centre for the employees, whose welfare receives full recognition, to judge from the notices prominently displayed at the entrance.

Motor boats and vehicles are useful in peace as in war, and in the production of both of these Messrs. Thornycroft will find in the future constant occupation for their well-equipped and greatly extended works. We all trust, however, that one very important department of their manufacture—that of bomb throwers and trench mortars—will never again be needed. Nevertheless, they have played such an important part in winning victory that great interest attaches to them, and it is right that the very striking work done by the firm in their inception and manufacture should be put on record. The first device of this kind manufactured at Basingstoke was the Stokes trench mortar. A full account of its early design and gradual evolution appeared in our issue of June 28, 1918. We may, however, recall that the propellant was a small cartridge, the bomb falling on to a pin in the bottom of the tube to detonate the cartridge, which in turn expelled the bomb to a limited range, varying with the angle of the tube. The bomb rested in the muzzle of the barrel on a firing pin, the withdrawal of which allowed the bomb to drop by gravity, to be expelled again by the gas of the cartridge explosion. The shell of the bomb was by no means a precision fit in the barrel; indeed, the gun was of the simplest type and character and proved in actual use of surprising efficiency.

A fresh problem altogether, solved upon somewhat similar lines, concerned the manipulation of the large depth charges used in the anti-submarine operations. At first these were suspended from the counter of the vessel and cut clear, but accidents to the vessel itself were not infrequent. It became necessary to devise a safer means to deliver these depth charges clear of the vessel overside. Some positive control as to direction and delivery were also needed, since dropping charges in the vessel's wake was by no means a certain method of attacking an unseen object, which naturally followed a devious course. What was needed was to enclose a certain area with exploding charges as rapidly as possible, so as to leave the submarine no secure path of escape. To do this the charge had to be fired through the air, and to be capable of being directed towards various desired spots.

As in the trench mortar, there was no need for a heavy propulsive charge, and at all costs serious shock to the high explosive was to be avoided. Torpedoes are ejected by means of air compressed to 1,000 lbs. or more per square inch; the gradual expansion of this elastic medium causes no disturbance to the delicate internal mechanism of the device and does not risk premature explosion of its charge. The depth charge is detonated by a determined pressure of water for which its mechanism is set, so that it is dangerous, on account of inertia stresses, to subject it to direct explosive propulsion.

The solution of the problem due to Messrs. Thornycroft consisted in providing a separate explosion chamber of considerable size, as will be seen in the illustrations opposite. A relatively small amount of cordite was fired and turned into gas, acting as a piston on the imprisoned air, so that the actual bomb delivery was without shock. Further than this, a carrier having a cast-iron plunger, a slack fit in the smooth bore of the barrel at the muzzle end, was provided. Each time a depth charge was delivered the carrier was also lost. Upon the carrier the depth charge itself was centrally laid.

A few ounces of cordite in the shape of a regular pom-pom cartridge was inserted into the firing mechanism at the mouth of the "air bottle," and a spring-loaded pin plunger, controlled by a taper yoke piece and lanyard, impinged upon the cartridge. A 350 lb. charge could thus be safely delivered by about 4 ounces of cordite 150 yards clear of the craft. At first both barrel and "air bottle" were of steel, but the actual pressure developed in the barrel was low enough to allow cast-iron to be used, and practically all the bomb throwers for depth charges have been fitted with cast-iron barrels. The angle of barrel was fixed to provide an unvarying elevation.

THORNYCROFTS' WORKS AT BASINGSTOKE.

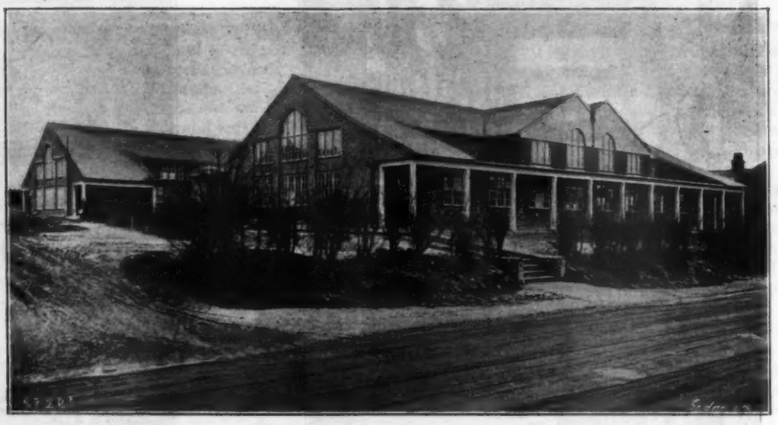


FIG. 5. THE CANTEEN.

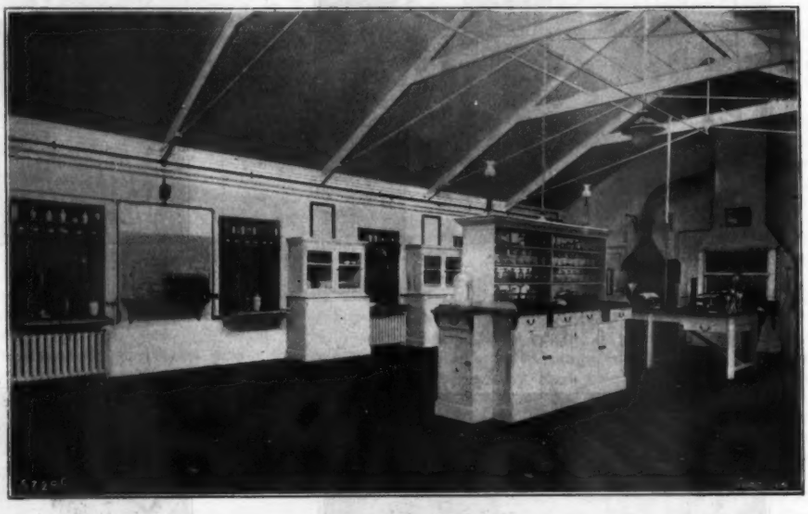


FIG. 6. THE METALLURGICAL LABORATORY.

Proceeding a step further, bomb throwers of much longer range made a very good showing in the final phases of the war. In the largest, a range of 1,500 yards with a 250 lb. bomb is obtained by 12,000 grains of cordite. An elevation of about 70 deg. from the horizontal gives a very high trajectory, with a vertical descent almost equivalent to release from a low altitude aeroplane. The charge is used naked, placed in the neck receptacle of the air bottle, and is operated upon by a small separate cartridge placed in the firing mechanism. A lanyard, taper yoke, and a spring plunger, constitute the same firing mechanism as in the depth charge thrower. The bombs themselves have a four fin tail, which gives steady flight and accuracy of placing, and are a very slack fit in the bore. In the long range thrower the barrel is lowered to a horizontal position, the bomb handled on a cradle is placed in the muzzle, and the elevation of the barrel allows it to slide to the bottom.

Two distinct types of thrower have been made, one in which the "air bottle" connects to the bottom of barrel by a curved tube (Fig. 7); in the other the two are spigoted together and held firmly by large clips.

Simple mountings are used; the recoil being very small presents no great difficulties, while the charge, used indirectly, involves small stresses. A simple indicator on the firing mechanism at the head of the air bottle indicates positively its condition, whether loaded or empty. The features

THORNYCROFTS' WORKS AT BASINGSTOKE.

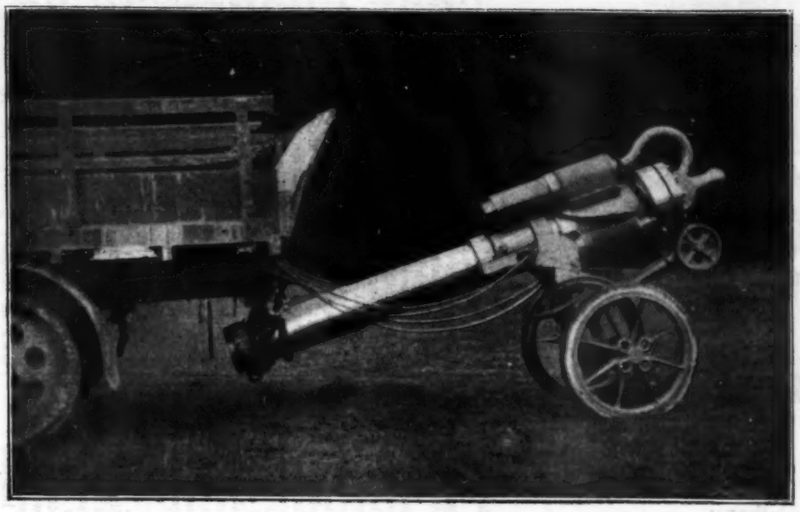


FIG. 7.

FIG. 8.

FIGS. 7 AND 8. DEPTH CHARGE THROWERS.

which distinguish the depth charge thrower from ordnance of more regular character, are the separation of the explosion chamber from the gun barrel, and the use of an explosion charge to compress and displace air which is the actual propellant medium. The absence of complexity and the proved efficiency of the apparatus for its intended purpose during the period of hostilities lend these throwers unusual interest.

The photographs on this page show two distinct types, one hitched to a W.D. lorry fitted for transport on wheels, the other mounted in a gun pit ready for operation.

When the history of the war comes to be written in detail it will be seen that Messrs. Thornycroft played a notable part in securing victory. Although Sir John Isaac Thornycroft retired from business some years ago, he has continually occupied his leisure in experimenting on boat forms, and much of the success of skimmers, or coastal motor boats, is due to his researches. It took scores of experiments with models to find the form that developed maximum speed with a given horse-power. The construction of these boats, and of others of the "mystery" type, has been carried out under the control of Sir John Edward Thornycroft, K.B.E., the son of the founder of the firm, under whose care the works have grown so enormously. However, this article is confined to the Basingstoke works, and what was done at Southampton is another story.

MODIFICATION OF BISMUTH ORDER, 1918.—The Minister of Munitions has issued an Order dated the 10th inst., which modifies the Bismuth Order, 1918. The obligations contained in Clause 2 (5) of the original Order are removed, so that it is no longer necessary for those who, in any manufacture, use Bismuth metal or any alloy thereof to make to the Controller on the first day of every calendar month a return showing the quantity of Bismuth metal or any alloy thereof received by him from the producer, the quantity consumed by him in such manufacture during the preceding month, and the stock in hand at the end of the said month. It is further provided that no return is required from any person whose total stock in hand and not intended to be used in connection with the manufacture or alloy of steel or other metal does not exceed in the case of bismuth metal or any alloy thereof, 56 lb.

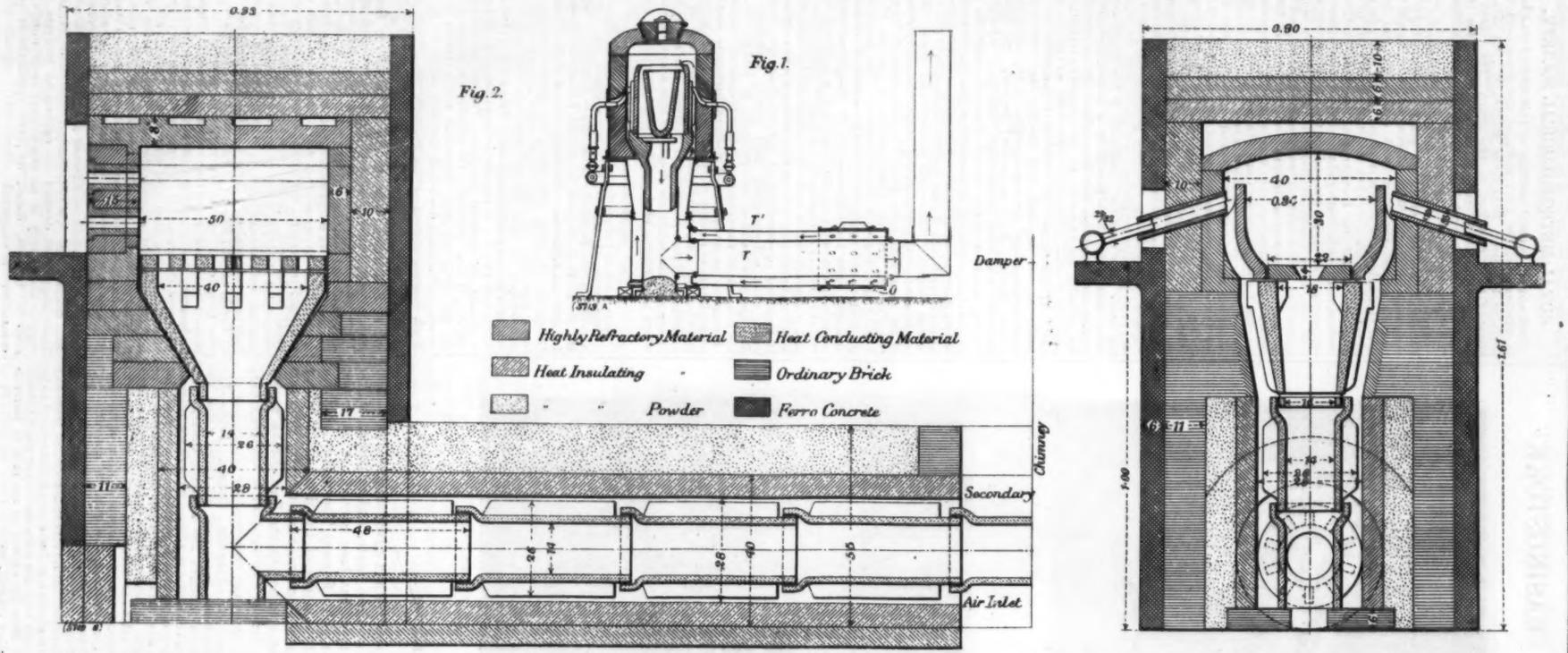
ROYAL METEOROLOGICAL SOCIETY.

THE annual general meeting of this society was held on Wednesday, the 15th inst., at the Rooms of the Geological Society, Burlington House, W., Sir Napier Shaw, F.R.S., president, in the chair. The report of the council for 1918 was read, and the council for 1919 duly elected, the president being Sir Napier Shaw, F.R.S., for his second year of office.

Sir Napier Shaw delivered an address on "*Meteorology: The Society and its Fellows*," of which the following is an abstract: Sir Napier Shaw referred to the change in the position of meteorological work during the war from that of a subject of curiosity which might safely be left to take its chance with such facilities as were left to the ordinary public by inexperienced censors and controllers, to that of a matter of such importance in gunnery and navigation of the sea and air that all reference to it was rigorously excluded from the newspapers and a number of special services were improvised to meet the need of meteorological information for our own forces acting in co-operation with corresponding organisations for the French, American and Italian forces. To meet the demand for information about the fundamental principles and practice of the modern science, necessary for those who were called upon to take up technical duties with very limited training, the Meteorological Office had issued a number of books specially written for the purpose. Looking forward, he said that the immediate necessity was the organisation of the meteorological services to satisfy the demands of the home countries and meet possible requirements of the dominions beyond the seas. The essential conditions of the organisation were, first, that there should be a career for men of ability and, secondly, that there should be opportunity for suitable preparation by preliminary training in scientific studies, including meteorology, at the universities. At the same time, efficient organisation of the public service required that the regular collection of information about the weather should be placed on a proper footing, by arrangement between the central authority and local authorities. The duty which the society should discharge in the changed conditions was to foster or create an atmosphere which would make a satisfactory national organisation on those lines possible by the interchange of ideas and the discussion of meteorological subjects. The steps towards this object would be the continued improvement of the Quarterly Journal of the society as a medium of communication between the Fellows, and the development of the use of the library as a reservoir of information. The position of the Fellows in relation to the subject would be somewhat changed when the maintenance of the forecasting of the weather came to be undertaken as a national duty. But the number of opportunities open to them for active personal co-operation in the development of meteorology, which had not hitherto been fully utilised, was very large. It included observations of special character such as those with self-recording instruments, including the photographic camera, co-operation in making known the progress of the science in other countries, the study of weather in ancient and modern literature and the presentation of a series of episodes in the long history of meteorology and, principally, the setting out of the experience of past and present study in such a way as to create and stimulate the desire for new knowledge upon which the progress of the science must rest.

SCIENTIFIC GLASS WARE.—In a paper on "Some Aspects of the Scientific Glass Ware Industry," which Mr. F. W. Branson read before the Society of Chemical Industry at Leeds last October (Journal of the Society, December 31, 1918, page 337), the author stated that after analysing the best Jena glass available and experimenting he had found that the following percentages gave a good borosilicate: Zinc oxide 7·5 to 8·5, Al_2O_3 6·5, BO_3 7. If the zinc content had to be reduced, it should be replaced by lime. Perfect annealing at 580 deg. C. was essential; the process was checked with the aid of an accurate pyrometer and a Hilger strain viewer. The glass described had been taken up by the York Glass Company, and the workmen liked it also, on account of its high plasticity at all temperatures, for making thin glass tubing and glass apparatus. Dr. W. E. S. Turner's analyses proved that some British glasses were better than any pre-war imported glass. There was, however, diversity of opinion as to annealing. Twyman had determined the variation of the glass viscosity with its temperature, and had given a formula from which, by measuring the viscosity at any convenient temperature, the proper annealing temperature could be deduced. According to A. Chaston Chapman reannealed glass was more resistant chemically than the original well-annealed glass; the glasses in question had been reannealed by Messrs. John Moncrieff, Limited, of Perth, on Mr. Branson's suggestion. This statement was questioned by Dr. Turner, who agreeing in this respect with the researches of the National Physical Laboratory, had not found that reannealing chemically improved the glass. Dr. Turner also remarked that the zinc in the described zinc-aluminium borosilicate was not essential for a good chemical glass; there were superior glasses not containing zinc oxide. The question of standardisation was also discussed; some chemists prefer to have more than the manufacturer's guarantee, viz., a certificate by the National Physical Laboratory or tests of their own, conducted after the method which Mr. English (of the Sheffield Department of Glass Technology) had devised for calibrating pipettes. As regards the history of an unnecessary large number of sizes of beakers, flasks, &c., the appointment of a committee was suggested.

OVENS AND KILNS WITH A HIGH THERMAL EFFICIENCY.



OVENS AND KILNS WITH A HIGH THERMAL EFFICIENCY.*

By A. Bigot, Dr. es-Sciences.

1. Industrial Laboratory Kilns.

In 1892, at the outset of my studies on stonewares and porcelains, I needed a laboratory kiln capable of rapidly attaining the temperature 1,400 deg. C. in an oxidising, reducing or neutral atmosphere; this object was easily attained by the addition of a sheet-iron recuperator to the Perrot kiln. (See Fig. 1.)

The tube T for the escape of the combustion gases is surrounded for a length of about 2·5 m. (100 in.) by a tube T′ of greater diameter; this tube T′ is pierced at its extremity by openings O, the dimensions of which can be easily regulated. When the kiln is kindled, the combustion gas draws in air from between the tubes T and T′; it makes a draught by the openings O, and the secondary air, which passes between the two tubes, arrives in the kiln hot and contributes towards the combustion of the gases.

In the Perrot kiln a mean temperature of 1,200 deg. was attained; with this modification it became possible to reach 1,400 deg. in the same time, that is to say, to raise the temperature of the interior of the Perrot kiln by 200 deg. without increasing the quantity of gas burned.

In 1915, I again took up the study of this kiln in order to obtain higher temperatures. I surrounded the sheet-iron recuperator with insulating materials, and, after this improvement, I obtained at the first firing a temperature of 1,750 deg. C. at the end of 5 hours, burning illuminating gas of inferior quality under a pressure of 40 mm. (about 1·6 in.) of water, and without air blast. After a first operation the refractories lining the interior of the kiln were half melted; at the end of the second firing the iron sheets of the recuperator were oxidised and perforated. To remedy these inconveniences I replaced the aluminosilicate parts of the interior of the kiln by more refractory materials, and constructed the recuperator with suitable refractories. (See Fig. 2 above.)

The kiln (Fig. 1) is of small internal capacity; only small objects can be heated in it, and the very hot zone is rather restricted. It was interesting to construct a laboratory kiln permitting regular heating of more important pieces and maintaining them for several hours if necessary at a fixed temperature.

When requested by the Minister of Munitions and War Manufactures to instal recuperative kilns of my pattern at the testing laboratory of the Conservatoire National des Arts et Métiers, I succeeded in meeting the requirements expressed above, with the co-operation of Captain V. Bodin, head of the third section of materials at the testing laboratory. This kiln is rectangular; the recuperator is the same as that of my 1915 kiln; the body of the kiln is lined with insulating bricks, and the upper part is covered again with a layer of incombustible insulating powder. The external structure of the kiln is strengthened with concrete, but it could be made of sheet iron. Internally, the kiln has a working capacity of nearly 2 cub. ft.; it could be reduced or increased.

From the first firing the temperature of the kiln reached 1,750 deg. at the end of 5½ hours. Above this temperature the refractory material of the interior of the kiln began to be deformed, and 1,750 deg. C. constituted the practical limit which could be attained with the actual refractory materials. The curve opposite (Fig. 3) indicates the rise of temperature of the kiln when fired, and on examining this curve it is easy to see that it was possible to reach a higher temperature. In this operation silica bricks and corindite bricks were heated; the former melted or were largely deformed. To attain this temperature the expenditure of illuminating gas, of inferior quality, was on the average 10 cub. m. per hour, under a pressure of 40 mm. of water and without air blast. Thus, by partial recuperation of the lost heat, and by the employment of insulating materials, I transformed the Perrot kiln, where a temperature of 1,200 deg. was attained, into a kiln where 1,750 deg. was attained, a temperature increase of 550 deg. without increasing the consumption of fuel.

2. Industrial Kilns.

1. *Intermittent Kilns.*—The preceding kiln is an intermittent kiln of small capacity; it is easy to adapt to industrial intermittent kilns the same systems of recuperation and insulation, whatever be the mode of firing; high temperatures will be obtainable in these kilns, which is practically impossible with the patterns in actual use. I have applied these principles to kilns with movable bottoms and with fixed hearths.

2. *Kilns with Movable Bottoms.*—These kilns, termed "tunnel kilns," offer advantages which I indicated by as exact calculations as possible in the lecture which I delivered at Stoke in 1915 (Trans., vol. xiv, page 115, 1915). My attention had then been called to the loss of heat which is produced in tunnel kilns by the wagons, the sides and the ground, and I indicated the effect of the judicious employment of insulating materials.

Insulating Materials.—Since that period I have completed my studies of these materials. A certain number of minerals occur in light powder which can, if necessary, be agglomerated in the form of bricks or special pieces, of small apparent density. These minerals contain a notable proportion of air shut up in their pores, which makes them bad conductors of heat; among these minerals may be named asbestos, light magnesia, infusorial earth, &c. A light powder of apparent density 0·2 can be agglomerated in the form of brick with sufficient crushing strength, of apparent density 0·5.

On comparing the conductivity of the refractory brick at ordinary temperature (conductivity 100 times less than that of gold) with the conductivity of the light powder of density 0·2, and that of the brick of density 0·5, the powder is found to be ten times less conducting, and the insulating brick six times less conducting, than the refractory brick. It is known that the coefficient of conductivity of refractory products increases rapidly with rise of temperature, and the same is the case with insulating products. At 800 deg. C. the conductivity of the insulating brick became six times greater, being then the same as the conductivity of the refractory brick at ordinary temperature. At 800 deg. C. the conductivity of the insulating powder equally became

* Paper read before the Refractory Materials Section of the Ceramic Society.

six times greater, but it was still inferior to that of the refractory brick at ordinary temperature. Above 800 deg. C., in proportion as the temperature is raised, the insulating powders tend to agglomerate, their volume diminishes, part of the air they contain disappears, and they have become more conducting. The agglomerates shrink, losing little by little the greater part of the confined air; they tend to become as compact as the other ceramic materials and their conductivity increases. According to my experiments the practical limit of temperature to which insulators can be submitted does not exceed 1,000 deg. C.; they ought then never to be employed for the internal lining of kilns.

The mean specific heat of refractory products and of insulating products is about 0·25 up to 1,000 deg. C.; the apparent density of ordinary refractory products is about 1·80, that of insulators above described is 0·50 for the blocks and 0·20 for the powder. It is easy to calculate the quantities of heat absorbed by equal volumes of these various materials; it is sufficient to multiply their weight by their specific heat and by the number of degrees Centigrade by which their temperature has been raised. The quantity of heat absorbed will be proportional to the apparent density of these products; the refractory product of density 1·8 absorbs 3·6 times more calories than the insulating brick of density 0·5; it absorbs nine times more calories than the powder of density 0·2.

Consider a kiln maintained internally at 1,000 deg. C., and of which the walls (0·69 m. or about 27 in. thick) are constructed of bricks 0·23 m. (9 in.) long; when equilibrium is reached the temperature of the external part of the brick will be, say, 100 deg. C.; the face of the brick at 100 deg. C. loses by radiation into the atmosphere a certain number of calories which can be easily determined. The heat received by the internal wall of the kiln can be divided into three terms: (A) The quantity of heat necessary to raise the temperature of the walls, arches and foundations of the kiln till equilibrium is reached. (B) The quantity of heat which radiates into the atmosphere owing to the difference of temperature between that atmosphere and the external walls of the kiln. To this quantity of heat lost by the air must be added the quantity of heat lost in the ground by conductivity. (C) The quantity of heat which the internal wall radiates into the interior of the kiln.

Retaining in the kiln the range of internal refractory bricks of 0·23 m. (9 in.) thickness, I replace the two other ranges of bricks forming a thickness of 0·46 m. (18 in.) by an insulating brick which is six times less conducting; this brick then should be one-sixth as thick, 0·0766 m. (3 in.), in order to preserve in the wall as a whole the same conductivity. The quantity of heat absorbed by this new wall composed of refractory bricks and insulating bricks will be a little more than a third of the heat absorbed by the wall of 0·69 m. thickness. In place of this insulating brick of 0·0766 m. thickness, I put round the kiln a quantity of powder in such a manner as to preserve on the whole the same conductivity; this layer of powder will have a thickness of 0·046 m. (about 1·8 in.). The quantity of heat absorbed by this new wall will be still smaller than in the preceding case.

The walls of the kiln constructed with a range of bricks 0·23 m. thick surrounded by 0·046 m. of insulating powder fulfil the same purpose as the brick wall 0·69 m. thick, but they absorb about one-third as many calories; the loss by radiation into the air and by conductivity into the ground is the same in the two cases; in order to remedy this loss of heat by radiation into the air and conductivity into the ground, and to make it almost nothing, it is sufficient to increase the thickness of the insulating light bricks or powders which then form a kind of eider-down around the kiln; the thickness of these insulators should be 0·10 m. to 0·50 m. (about 4 in. to 20 in.), according to the internal temperature of the kiln, in order to obtain good insulation. The heat B, which will no longer radiate into the air and that which will no longer pass away into the ground, will return into the interior of the furnace as radiant heat, which will promote a rise of temperature. The use of the insulating material thus effects a double economy in calories.

Before undertaking a complete trial of the process of insulation on a whole kiln, I made a partial application on the arch of an intermittent kiln. The arch of this kiln had been constructed with refractory bricks 0·23 m. thick, and this arch, in a first experiment, had been re-covered by a layer of 0·25 m. of rather coarse sand. The kiln being kindled, a temperature of 1,230 deg. was obtained at the end of 78 hours. In a second trial, carried out under the same conditions, the sand was replaced by a layer (0·15 m., or 6 in.) of insulating powder; a temperature of 1,320 deg. was reached at the end of 26 hours, firing with an expenditure of fuel half that of the preceding operation; after 58 hours' heating the temperature reached was 1,465 deg. The curve above (Fig. 4) traces the course of the trial. The numbers on the horizontal lines indicate the temperatures attained in degrees Centigrade; those on the vertical lines represent the hours from the commencement of the operation. The curve A is that of the first trial, the curve B that of the second.

Refractory Materials.—The wagons hitherto adopted in tunnel kilns move on wheels or on metal rollers, which it is necessary to cool in order to avoid corrosion. The wagons are cumbersome, they involve an increase in the size of the tunnel and bring about important heat losses. In order to remedy these inconveniences as far as possible I employed the following method. The material to be fired is supported on plates which move by means of a system of balls rolling on a fixed floor, the whole being made of special refractory materials having three chief qualities: (1) Resistance to wear and tear at both high and low temperatures; (2) crushing strength at various temperatures; (3) ability to withstand changes of temperature. If these three qualities are not combined the practical employment of these wagons is impossible. After a series of studies on resistances to wear and tear or ability to resist changes of temperature, and crushing strength up to 1,500 deg., undertaken with different materials, I succeeded in solving the problem. It is known from the experiments of Captain V. Bodin, that a great number of refractory products present a maximum crushing strength between 1,000 deg. and 1,200 deg., and that above this temperature the strength decreases very rapidly. Certain refractory products attain at about 1,100 deg. a crushing strength of 1,700 kg. per square centimetre.

The materials I use for the rolling plates belong to the category of those which offer this high resistance; they can be heated to 1,100 deg. without suffering deformation. In my tunnel kilns intended to reach about 1,100 deg. the rolling system is carried to the same temperature as the goods which it supports, and its volume is reduced to the minimum; I have given to these kilns, which will be described briefly further on, the name of "tube-kilns."

For temperatures above 1,100 deg., prudence requires that the rolling system be not submitted to a higher temperature; in a kiln heating to 1,550 deg., the balls are about a foot below the goods; I have called these "tunnel kilns."

In these kilns, completely surrounded by insulators, very little is lost either by the air or into the ground, as I demonstrated above; since everything in them maintains a high thermal efficiency their dimensions can be reduced and they can be adapted to the firing of small lots, whereas the tunnel kilns hitherto employed can only be economically used for the firing of large quantities. The temperatures obtained in my tunnel kilns are comparable to those which I reached in my industrial laboratory kiln.

Description of the Kiln with Movable Bottom.—Tube kilns and tunnel kilns require five principal parts: A. The rigid covering. B. The bottom of the kiln. C. The tube or tunnel. D. The movable parts and the rolling way. E. The insulating covering.

A. *Rigid Covering.*—This covering consists of a body of ferro-concrete represented by the sections in Figs. 5 and 6. Vertical parallel pillars are supported by horizontal beams at their base and top, these beams being parallel and perpendicular to the axis of the kiln; the two vertical faces, between the pillars, are filled up with ordinary bricks, laid flat on a width of 0·11 m., with cement or lime mortar. A long, rigid but light chamber is thus obtained.

B. *Bottom of the Kiln.*—The lower part of the chamber is filled up to a suitable height with insulating concrete resting on the ground; on this concrete one or two ranges of insulating bricks are laid out, placed flat with insulating grout; the surface of these bricks should be as plane as possible, and it is on this surface that the other three parts of the kiln are established.

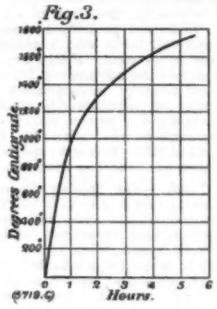
C. *Tube and Tunnel.*—They are composed of two vertical walls of bricks 0·23 m. in thickness, terminated above by an arch of bricks of the same dimension or by large curved slabs forming a roof. The material and the form of the bricks or slabs vary according to the temperature to be obtained in the kilns.

The interior of the tube kiln is provided from end to end with hollow refractory materials, which are as highly conducting as possible; the introduction of the air, the combustion, and the ejection of the gases occur in these passages.

In order to ensure rigidity of the tube or tunnel it is necessary to place opposite each vertical pillar of ferro-concrete a wall 0·11 m. thick of insulating bricks, which starts from the external wall of the tube or tunnel and rests against the vertical pillars of ferro-concrete (Figs. 5 and 6).

D. *Movable Part and Rolling Way.*—The lower part of the tube and tunnel is provided with special refractory slabs made of the same material as the balls and the movable plates, and on these lie the movable balls. The dimensions and shapes of these slabs are variable. In the tunnel kiln the movable wagon is provided with a refractory chamber covered with plates which carry the materials to be fired (Fig. 6).

Fig. 3.



(5719.C)

Fig. 4.

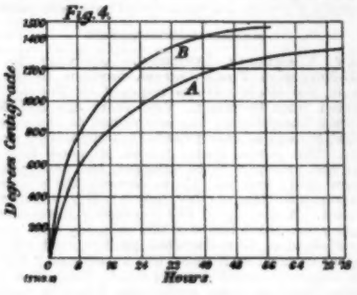
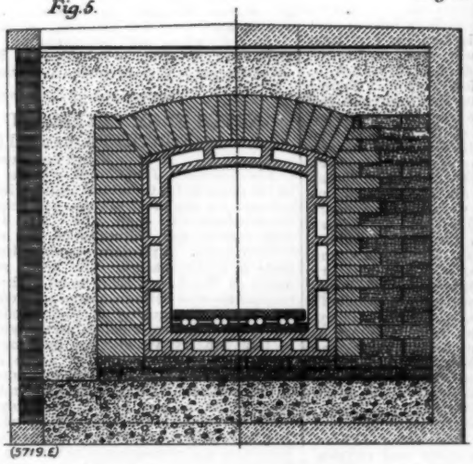
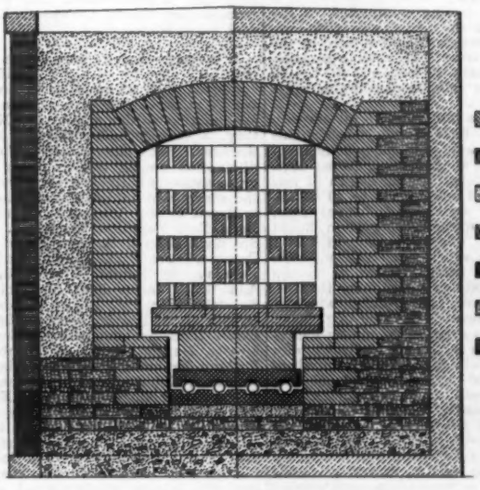


Fig. 5.



(5719.E)

Fig. 6.



Tube Kilns.—There are muffle kilns which can be heated up to 1,100 deg., in an atmosphere which can be made at will oxidising, reducing or neutral. These kilns are likely to be of interest in a great number of industries: (1) Re-heating of metals, enamelling of metals; (2) annealing of glass, enamelling of glass; (3) fine earthenware, decoration of ceramic products; (4) crucibles and other materials made of plumbago or graphite; (5) various chemical products, &c.

The temperature of these kilns is limited because of the low crushing strength above 1,200 deg. C. of the refractory materials actually used; but studies in progress suggest that in the near future refractory products with a resistance at above 1,500 deg. C. of more than 600 kg. per square centimetre of surface, will be manufactured. The field of application of tube kilns will then become much greater.

Tunnel Kilns.—With the refractory materials actually at disposal, tunnel kilns can be heated practically up to 1,100 deg. The arrangement shewn in Fig. 6 is that of a kiln directly heated; the combustion gases traverse the ware. This tunnel kiln can be heated, like a muffle, both by radiation of heat on the two sides and by the arch.

My first tunnel kiln with direct heating was constructed at Paris two years ago in one of the factories of M. Guérineau, president of the Syndicate of Ceramic Products of France. This kiln, which was intended to fire, at high temperatures, about 3 tons of special refractory bricks, has very small dimensions, and yet very high thermal efficiency. It has served at the same time as an experimental furnace for firing very varied products.

For several practical reasons the fuel adopted was illuminating gas of reduced calorific power, about 8,000 calories per kilogramme, similar to the caloritic power of coals of ordinary quality. This kiln is heated with simple Bunsen burners, like a Perrot kiln; but the greater part of the air which serves for combustion passes over the fired and hot goods before mixing with the gas, which causes a considerable rise of temperature. Thanks to a special arrangement, the fired products can be cooled pretty rapidly and the greater portion of the heat which they contain can be recovered again after the passage of the air necessary for combustion; it is known, in fact, from calculations established in my lecture at Stoke in 1915 that the air necessary for combustion recovers from the fired goods only a third of the heat which they have absorbed. This cooling arrangement allows shortening, by half, the length of the tunnel kiln between the firing zone and the discharging place for the wagons.

But this kiln allows only a length of 15 m. between the fireplaces and the exit flues for the gases; this length is quite insufficient, and, from measurements of the temperature of the gases at the outlet, 20 per cent. of the heat escapes in the flues. If the length of this part of the kiln were doubled and carried to 30 m. the loss of heat by the chimney would fall to 10 per cent., so that this tunnel kiln of normal construction should have a length of about 50 m., the same as for firing at a high temperature. The heat which escapes through the flues and the heat recovered from the ware in cooling can be utilised to dry the products before firing them.

Consumption of Fuel.—From the results which I obtained in 1915 for kilns heated to 1,000 deg., from new results which have been supplied to me by manufacturers since then, and with the official report of daily consumption of my tunnel kiln, the following numbers can be considered as accurate: An intermittent kiln heated to about 1,000 deg. utilises 20 per cent. of the calories of the furnace; heated to 1,400 deg. it utilises 10 per cent. of the calories of the furnace. An ordinary Hofmann kiln heated at 1,000 deg. utilises 40 per cent. of the calories of the fuel. A Hofmann kiln heated by the gas producer to 1,250 deg. utilises also 40 per cent. of the calories of the fuel. A tunnel kiln with wagons utilises, at 1,000 deg., 80 per cent. of the calories; at 1,250 deg. this number falls to 50 per cent., and between 1,360 deg. and 1,400 deg. it scarcely reaches 40 per cent.

My tunnel kiln at 1,250 deg. utilises 78 per cent., and at 1,450 deg. 70 per cent. of the calories of the fuel; if the length be sufficient it will utilise more than 85 per cent. of the calories; it is therefore the kiln which gives the greatest thermal efficiency among those which are employed in industry.

Heating of Materials.—The materials which have been successfully fired in this kiln include the following: (1) At 1,250 deg., stoneware and alumino-silicate refractories, with a consumption of 50 kg. of fuel per ton of fired products; (2) at 1,350 deg., porcelain insulators, with an expenditure of 61 kg. of fuel per ton of goods, including the supports; (3) at 1,450 deg., porcelain insulators, cements, bauxite products, corindite and chromite, with a consumption of 75 kg. of fuel to the ton; (4) at 1,530 deg., magnesia products, with a consumption of 105 kg. of fuel. At the same temperature the firing of silica bricks requires a longer time and the consumption is raised to 130 kg. per ton; the products are perfectly fired and homogeneous; there is no loss in the firing, of which the duration from the setting in the kiln to the drawing does not exceed 5 hours. This kiln is the one which gives the best results for the firing of such awkward materials as silica products.

The heating of these kilns is carried out equally well by means of gas producers. However, with this process, care must be taken that the gases lose no part of their heat before penetrating into the kiln; in order to avoid this loss the gas producer and gas passages are completely insulated by the processes employed for the kilns.

Deliveries from the Kilns.—The kilns represented by Figs. 5 and 6 can deliver per 24 hours, from 15 tons to 25 tons of goods according to the density of these goods and the conditions of firing; the chief principle of their firing, even with direct flame, being radiation of heat, it is therefore necessary not to increase too much the capacity of the wagons if it is desired to obtain a sufficiently uniform temperature in the firing. For a production greater than that indicated above it will be preferable to employ a two or three-way tunnel placed in a single chamber of ferro-concrete.

According to the materials to be heated, the system of heating, the forms and dimensions of the kilns, and the refractory materials used vary, but the system of rolling and the principle of insulation of the kilns on all the surfaces is invariable.

I omit details regarding accessories such as dryers, tracks for the return of the wagons, apparatus for measuring temperature and pressure in the kilns, analysis of gases, ejection of the combustion gases, apparatus for driving the wagons, &c.

To sum up, these new kilns with movable bottom present the following characters: They are simple, not very costly, and require little manual labour. Their length is not appreciably great, and are available for high temperatures; in particular they have solved the difficult problem of firing silica products. They consume less fuel than the other kilns hitherto employed.

NOTE.—The tube and tunnel kilns have been patented.

NEW NORWEGIAN INDUSTRY.—According to *The Anglo-Norwegian Trade Journal*, previous to the war most of the electric lamps required in Norway were imported from Germany. Two years ago A/S Norsk Elektrisk Lampefabrik was established at Drammen as the first Norwegian enterprise for manufacturing electric lamps. The lamps made proved so good that the works had promptly to be enlarged, and new buildings are now ready for use. Up to recently the production was about 4,600 lamps a day, now it will be considerably increased. According to *The Norwegian Mercantile and Shipping Gazette* the lamps of this company were quickly acknowledged to be a first-class product, but owing to the great demand in Norway the number of "N.E.L." lamps exported is still limited; Dr. E. Naef, who is the superintendent of these works, was formerly similarly employed in Switzerland. The present directors of the company are Messrs. A. Foyn, G. Thorkildsen, A. Stephan and Tollef Kilde.

L'INSTITUT DE FRANCE.—The highest honour that can fall to the lot of any scientific man has just been conferred upon an American engineer, when, on December 17, at Paris L'Institut de France elected Dr. J. A. L. Waddell, consulting engineer of New York and Kansas City, a Corresponding Member in the Academie des Sciences. Such membership is the most highly-coveted distinction among the scientists of Europe; for the organisation is both old and exceedingly select. Among the many distinguished men who in time past have belonged to the Academie might be mentioned Count Berthellet, Napoleon Bonaparte, Sir David Brewster, Sir Mark Brunel, Bunsen, Baron Curvier, Sir William Crookes, Dana, Encke, Sir William Fairbairn, Sir Michael Faraday, Sir Edward Frankland, Sir John Franklin, Ada Gray, James Hall, Hemholtz, Sir William and Sir John Herschel, Baron Humboldt, Thomas Henry Huxley, Lord Kelvin, Langley, Laplace, David Livingstone, Lord Avebury, Sir Charles Lyell, Metchnikoff, Mosely, Hanson, Simon Newcomb, Sir William Perry, Pasteur, Sir James Ross, Sir William Ramsey, Henry A. Rowland, Count Rumford, Secchi, James Watt, and Baron Wrangell. L'Institut de France is composed of five academies, the principal one of which is the Academie des Sciences. That organisation is restricted to a full membership of 66, all of whom must be citizens of France; and, in addition, there are 116 Corresponding Members scattered all over the world. The Academie is divided into two groups—mathematical sciences and physical sciences. The former is subdivided into five sections, viz., those of geometry, mechanics, astronomy, geography and navigation, and general physics; and the latter into six sections, viz., those of chemistry, mineralogy, botany, rural economy, anatomy and zoology, and medicine and surgery. Each of these 11 sections, excepting that of astronomy, which has 16, is allowed 10 Corresponding Members, who may be residents of France or of any foreign country, so that a scientific specialist, however great his renown, must await not merely a vacancy in the Academie, but one in the particular section to which he belongs. The full membership of 66 is equally divided between the 11 sections. By this means an equal balance is always maintained, and there can be no undue preponderance of any single scientific branch, or of any group of such branches. For a year past there has been a vacancy in the list of Corresponding Members in the Mechanical Section, owing to the death of General Zaboudski, of Russia, who was assassinated during an uprising of the populace at Petrograd. After considering the matter for several months, the Academie finally chose Dr. Waddell to fill the vacancy, basing their selection upon the value to practical science of his numerous books, papers, and addresses on both the theory and the practice of engineering, as well as upon his contributions to the development of technical education. One of his books, by the way, was translated into French, and was published some three years ago by the French Government. The Academie des Sciences was inaugurated in 1795; and during the succeeding 123 years their have been only 18 Corresponding Members chosen from the United States, Dr. Waddell making the nineteenth. Of these 18, three are still living, viz., the astronomers Dr. Edward Charles Pickering, of Harvard University, and Dr. George Ellery Hale, of Washington, D.C., and the geographer, Dr. William Morris Davis, of Cambridge, Massachusetts.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Steel Trade.—Despite the fact that the new 47-hours week has not met with general approval—and for this various reasons are adduced—the immediate future of the steel trade, as of allied industries, is particularly bright. A considerable amount of repair work has been put through during the holidays, so that once the works get into full swing again there is every likelihood of an era of brisk activity. Finished steel is in active demand, both for home and export, but meantime the home consumer is getting whatever advantage there is, the scarcity of fuel and the uncertainty of transport still standing in the way of extensive shipments. Although there is not much prospect of any immediate fall in prices a certain reticence is noticeable in some quarters, the continuance of Government control being looked upon rather in the nature of a deterrent to normal business conditions than otherwise.

Malleable Iron Trade.—The malleable iron industry has made a good start after the holidays, and everything points to keen business and continued activity. Orders are plentiful and works fully employed, mainly, of course, with home contracts. Bar iron of all grades is greatly in demand, while the pressing necessities of the shipbuilding yards call for a very considerable tonnage of bolt, nut and rivet iron. Prices are still a very uncertain quantity—the advance in home rates last week being followed now by an increase for export. These matters cannot be satisfactorily remedied until such times as the control of prices, &c., is once more in the hands of the makers who, naturally, are best qualified to fix the rise and fall. It is not expected that "Crown" bars will change hands at less than 18*l.* 10*s.* per ton.

Pig-Iron Trade.—The holiday season, during which time the smelting furnaces were in full blast, has enabled producers to accumulate some little stock, and so ease the situation to some little extent. All over the demand continues, every brand being much in request, with a better supply of hematite available for general purposes since the steel works no longer require it for munitions, and other war material. With the home markets absorbing practically every ton as soon as it is produced, export has not yet got a look in. While there is still a certain quantity of foundry iron, both it and forge are in constant demand, and appearances tend to show a continuance of good business, which will be further improved when the requirements of the overseas customers can again be considered. So far the Government control of prices remains as it was.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—There is no abatement in the demand for Cleveland foundry iron, both for home use and for shipment abroad, and requirements cannot be anything like dealt with. No. 3 in particular is very scarce, and deliveries of this quality are on a reduced scale. A plentiful supply of forge iron, however, finds a ready market. The latter realises the same figure as No. 3, and there is no difficulty in selling it, so that there is little incentive to producers to attempt to improve the quality of their production. France's needs are becoming smaller, and in addition, shipments to that country are checked by congestion at French ports. The position is even worse at Italian ports, where it is stated iron is laid and cannot be conveyed to the interior. Efforts to purchase on behalf of neutrals, however, are as keen as ever, but they meet with little or no success as there is practically no iron to spare for such trade, and export licences are very difficult to obtain. Increasing apprehension is felt that with freights declining America may capture certain neutral markets. For home consumption, No. 3 Cleveland pig-iron, No. 4 foundry, and No. 4 forge are all quoted 95*s.*, and No. 1 is 99*s.*; and for export, No. 3 and the lower qualities are 145*s.* and No. 1 is 150*s.*

Hematite Iron.—In this branch the production barely meets the heavy home requirements, and consequently foreign trade is about at a standstill. Hope is expressed that output will be increased, but there seems little likelihood of that occurring to any extent, at all events, in the near future. Mixed Nos. are 122*s.* 6*d.* for home use, and 172*s.* 6*d.* for export.

Discontinuance of Control Certificates.—The welcome announcement is made that the issue of pig-iron control certificates is discontinued. This means that merchants are no longer required to specify consumers works for which iron is intended, to state the price on trucks, cost of carriage, and amount of their commission. The intimation of the discontinuance of control makes no reference to prices.

Foreign Ore.—Further inquiries for foreign ore are in the market, but the actual business passing is only small. Supplies against running contracts are coming forward satisfactorily.

Coke.—Coke is very firm and scarce. Some of the ovens at the collieries where the cokemen were on strike last week are working badly owing to the coke not having been drawn, and supply from such ovens is poor. Average blast-furnace coke is 33*s.* at the ovens; and low phosphorus quality, 35*s.* 6*d.* at the ovens. Up to 70*s.* f.o.b. is paid for foundry coke for neutrals, and some firms ask even more; and gas-house kind is round about 65*s.* for shipment.

Manufactured Iron and Steel.—Producers of finished iron and steel have heavy contracts made, and there are

any number of orders in the market, but many manufacturers are disinclined to commit themselves further until some uncertainties are removed. Demand for railway material is exceedingly heavy. The following are the principal market quotations to home customers:—Common iron bars, 15*l.* 12*s.*; iron ship rivets, 22*l.*; steel ship, bridge, and tank plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 13*l.* 10*s.*; chequer plates, 13*l.*; steel joists, 11*l.* 2*s.* 6*d.*; heavy sections of steel rails, 10*l.* 17*s.* 6*d.*; and steel billets, 10*l.* 7*s.* 6*d.* to 11*l.*; whilst among the principal export quotations are: Common iron bars, 20*l.*; steel ship, bridge, and tank plates, 16*l.* 10*s.*; steel angles, 16*l.* 2*s.* 6*d.*; steel boiler plates, 17*l.* 10*s.*; chequer plates, 18*l.*; steel joists, 16*l.* 2*s.* 6*d.*; heavy steel rails, 15*l.* 10*s.*; and steel billets, 13*l.* 10*s.* to 15*l.*

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Hull Coal Trade.—The returns of the Hull coal trade show the receipt of only 2,605,602 tons, a great contrast to pre-war days, and a decrease of 206,754 tons compared with 1917. A sign of improvement was, however, noted last month, when the receipts reached 177,402 tons, an increase of 5,048 tons compared with the corresponding month in 1917. The main contributors to the trade were Denaby and Cadeby Main Collieries, with 301,208 tons in 1917 and 229,045 tons last year. The receipts for 1918 were the lowest for the past twelve years. The returns of the last six years show the following figures: 1913, 7,945,965 tons; 1914, 5,652,633 tons; 1915, 4,667,733 tons; 1916, 3,290,281 tons; 1917, 2,812,356 tons; and 1918, 2,605,602 tons. The amount of the exports have not been communicated to the public for a considerable time, but the majority have been for the Allied Governments and the Admiralty Department.

Iron and Steel.—Business in the iron and steel industries in the district is of a fluctuating and varied character. In some branches there is the utmost depression, whilst others are booming. All, however, are seriously perturbed at the unrest among skilled labour. The 47-hour week has met a hostile reception in Sheffield, where the skilled men are agitating for a 40-hour week, continuous shift working, with Saturday and Sunday holiday. Efforts are being made by the employers to fix times for starting and stopping work under the 47-hour week, but the men have intimated that these arrangements are only temporary, and that a fortnight hence they will have to be drastically revised. This state of affairs accounts to some extent for the depression. Probably the most unsatisfactory of all branches is the trade in high-speed steel, the demand for which has dropped from an eager call for every pound that could be manufactured, to far below pre-war level. Doubtless, as the works become adapted to peace requirements, a marked improvement will be noted. Electric furnaces, largely engaged on the manufacture of alloy steel employed on aircraft construction, are at present finding but little work. Makers of heavy steel, too, such as basic and acid billets, find consumers very chary of buying except for immediate necessities, while the pig-iron trade is in much the same position. More satisfactory are the reports from makers of railway and tramway material. Orders for railway track, rolling-stock and stores have been pouring into the city. The local rail mills are running full time. Marine and shipbuilding engineers, too, are placing large contracts. In the twist drill and engineers' small tools departments there is the utmost congestion. Bookings continue to come from Continental markets for the cheaper qualities of steel. The stock of agricultural implements and tools in the country is sadly in want of replenishment, and brisk business is being done.

South Yorkshire Coal Trade.—In the Sheffield district there is very little change of affairs. Best steam coal is going away freely to all classes of home consumers, and there is a steady demand for export. Blast-furnace coke is not so active owing to a number of furnaces being down for repairs, but the prices remain as before. Cobbles, nuts and slacks are all a strong market, and are firmly held by contractors, there being little or nothing left for the open market after their demands have been attended to. In the house coal section the supply is not equivalent to the demand, and consequently there is a general shortage at most depots. Full rates obtain and prices are at the maximum. Quotations:—Best branch handpicked, 27*s.* to 28*s.*; Barnsley best Silkstone, 27*s.* to 27*s.* 6*d.*; Derbyshire best brights, 25*s.* to 26*s.*; Derbyshire house coal, 22*s.* 6*d.* to 23*s.* 6*d.*; best large nuts, 22*s.* 6*d.* to 23*s.* 6*d.*; small nuts, 21*s.* 6*d.* to 22*s.* 6*d.*; Yorkshire hards, 22*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire hards, 21*s.* 9*d.* to 22*s.* 9*d.*; best slacks, 18*s.* to 19*s.*; seconds, 16*s.* to 18*s.*; smalls, 13*s.* to 14*s.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—Over the last week-end there was a very considerable increase in the supply of tonnage, and colliery stems are now, therefore, pretty full. It is, however, apprehended that the position may not be so favourable next week. The action of the authorities in removing the restraints on the employment of neutral steamers is generally approved by the coal-exporting community, but the conditions which have during the past four or five months regulated the supply of coal to neutrals are acting as a restraint on new business, and steps are already being taken to remove them. It is stated that it is probable that at an early date the practice of imposing surcharges on the neutral schedule prices will be discontinued, while there is a growing demand for a greater freedom of action with the arrangement of business with neutral countries generally. It is now announced officially that the interpretation of the recent Order increasing the price of patent fuel by the Coal Controller is that as from January 1 the price of patent fuel is 39*s.* 6*d.*, and patent fuel in ovoid shape (which are manufactured in the Swansea district) 37*s.* 6*d.* There is but little improvement in the pitwood position. The Allocation Committee, however, is dealing efficiently with the question of the distribution of available stocks, and if these do not show any substantial increase they are being successfully maintained at the level of the figures of two or three weeks ago.

Newport.—Shipments of Monmouthshire coals are very active, and collieries in the Eastern and Western Valleys are again well stemmed. The demand is greatest for the steam coal qualities, but the inland demand for the more bituminous descriptions is being well maintained, and deliveries are fairly regular.

Demobilisation of Miners.—There has recently been some disquietude in regard to the re-employment of demobilised miners, and there are a number of men in the coalfield of the pacifist type, who would only be too ready to capitalise any opportunity to create industrial strife. Fortunately, the South Wales coalowners have taken time by the forelock, and a special meeting of the Association was held on Saturday, when it was decided to communicate to all the colliery companies the following directions with regard to the reinstatement of miners who are being discharged: (1) "That no new workman be employed at the collieries except discharged soldiers and sailors," and (2) "that as far as possible each colliery company must only engage discharged soldiers and sailors who were in their employ prior to enlistment, except when otherwise instructed by the Joint District Demobilisation Committee." It may be explained that the Demobilisation Committee which has been set up is composed of representatives of both the owners and the workmen, and its functions are to deal at once and effectively with any difficulty that may arise.

MINERALS IN THE STATE OF VICTORIA.—According to the annual report for 1917 of the Secretary for Mines of the State of Victoria, the yield of black coal during that year was 466,220 tons, value 335,259*l.*; and that of brown coal 39,144 tons, value 10,571*l.* The other minerals raised were antimony 2,572 tons, value 58,489*l.*; tin 139 tons, value 19,709*l.*; wolfram 22¼ tons, value 3,600*l.*; molybdenite 50 tons (ore), value 500*l.*; magnesite 74 tons, value 222*l.*; infusorial earth 750 tons, value 2,600*l.*

RELEASE OF BRITISH TONNAGE.—The Shipping Controller desires to intimate that British ships as they complete their voyages, on and after March 1, at ports of re-delivery in the United Kingdom, or in exceptional cases at ports abroad, will be released from requisition, except in so far as they are required for Government purposes, or are ships to which special conditions apply, and shipowners in general are now free to make arrangements for the employment of their ships from the time indicated, subject to employment and charters being approved by the Controller and the necessary licences for proposed voyages being obtained. With a view to safeguarding the essential imports and exports of the United Kingdom and of the Allies, it will be necessary for some time to come to maintain a system of direction as to employment, and a limitation of freight rates for the carriage of such essential commodities. All owners will have full liberty to negotiate employment through their own agents or brokers. The Shipping Controller is hopeful that all essential services will be adequately provided for under the above arrangement, but it is, of course, to be understood that the power of requisition is held in reserve for use at any time should the necessity arise. This notice does not apply to ships wholly engaged on naval or military services.

THE LATE PROFESSOR CONRADIN ZSCHOKKE.—Professor C. Zschokke, who died in Aarau in December last, was one of the best-known Swiss hydraulic engineers, and was connected with many important installations in the South and West of Europe. Born in Solothurn, in 1842, he studied at the Zürich Technical High School, went to Paris in 1865, and joined the firm of Antoine Castor and Hersent; after Castor's death, he conducted the business for some years in his own name. In 1891 he accepted the appointment as professor of hydraulic engineering at Zürich; elected into the National Council in 1897, he continued to lecture; later, he became a member of the Swiss educational council and president of the Commission for Weights and Measures. Among his early works are the harbour works of Bone, Algiers, the Franz Josef Bridge in Vienna, the harbour basins at St. Malo and at Bordeaux, and some weirs on the Seine. In 1880, he was put in charge of the regularisation of the Tiber, at Rome, a project which necessitated also the construction of three bridges, and was, during the same time, engaged in the construction of two dry docks at Genoa. After his return to Switzerland, in 1890, he was connected with many of the large new hydro-electric installations of the country, at Rheinfelden, Laisfenburg, Beznau, &c.; he was responsible also for laying the foundations of the central railway station at Amsterdam, and he built some big harbour basins at Marseilles, and dry docks at Cadiz and Venice. His college conferred the honorary degree of Dr.Ing. on him when he ceased to teach there. The recent influenza epidemic claimed two other Swiss engineers among its victims, Max Schock of the firm of Schock and Company, Zürich, who had for some time worked with Messrs. Platt Brothers, at Oldham; and Hans Eberhard, of the firm of L. von Roll, iron works and mills, where he introduced electric driving. Both these engineers were little more than thirty years old.

NOTICES OF MEETINGS.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, January 17, at 7.30 p.m., at 39, Victoria-street, Westminster, S.W., on "Recent Improvements in Electric Lamps," by Captain R. S. Mullard, R.A.F.

THE ILLUMINATING ENGINEERING SOCIETY.—Tuesday, January 21, at 8 p.m., at the House of the Royal Society of Arts, John-street, Adelphi, London, when a discussion on "Modern Practice in Office Lighting" (counting houses, banks, insurance offices, drawing offices, &c.) will be opened by Mr. A. Wise.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday, January 21, at 5.30 p.m., at the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. The following paper will be read: "Paraffin Wax and its Manufacture," by Mr. Andrew Campbell, F.I.C., and Mr. W. J. Wilson, A.I.C. The chair will be taken by the president, Mr. Charles Greenway.

THE JUNIOR INSTITUTION OF ENGINEERS: NORTH-EASTERN SECTION.—Tuesday, January 21, at 7.15 p.m., at the Mining Institute, Neville-street, Newcastle-on-Tyne. Paper on "The Design of Heavy Switch Gear," by Mr. F. A. Orchard.

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, January 22, at 8 p.m., at the Royal Institution, Colquitt-street, when a paper will be read by Mr. H. C. Ritchie, Assoc.M.Inst.C.E., entitled "Some Problems of the Reinforced Concrete Ship."

THE ROYAL SOCIETY OF ARTS.—Wednesday, afternoon, January 22, a paper on "Meteorology During and After the War" will be read by Colonel Henry George Lyons, R.E., D.Sc., F.R.S., Acting-Director, Meteorological Office. The chair will be taken at 4.30 p.m. by Sir William Napier Shaw, Sc.D., F.R.S., Meteorological Adviser to the Government.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 23, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Lecture, to be followed by a discussion: "Planning a Works Research Organisation," by Mr. A. P. M. Fleming, O.B.E., Member.

THE PHYSICAL SOCIETY OF LONDON.—Friday, January 24, at 5 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington. Agenda (1) "Notes on Lubrication," by Principal S. Skinner; (2) "On Sir Thomas Wrightson's Theory of Hearing," by Professor W. B. Morton, M.A.; (3) "Electrical Theories in Connection with Parallel Cylindrical Conductors," by Mr. A. Russell, M.A., D.Sc.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, January 24, at 6 p.m., at the Institution of Civil Engineers, Great George-street, Westminster. Papers: "Electric Welding," by Mr. T. T. Heaton, of Uxbridge, Member; "The Development of the Oxy-Acetylene Welding and Cutting Industry in the United States," by Mr. Henry Cave, of Hartford, Conn.; "Oxy-Acetylene Welding," by Mr. J. H. Davies, of the Central Technical School, Leeds; and "Oxy-Acetylene Welding," by Mr. F. Hasledine, of the London and North-Western Railway Works, Crewe.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, January 24, at 5.30 p.m., a discourse will be delivered by Temporary Lieutenant-Colonel Andrew Balfour, C.B., C.M.G., M.D., R.A.M.C. The subject will be "One Side of War." Afternoon Lectures at 3 p.m.:—Tuesday, January 21, Professor Spenser Wilkinson, on "Lessons of the War" (Lecture II); Thursday, January 23, Professor J. Norman Collie, LL.D., F.R.S., on "Chemical Studies of Oriental Porcelain" (Lecture II); Saturday, January 25, Rev. Canon J. O. Hannay, on "The Irish Literary Renaissance" (Lecture II).

THE INSTITUTION OF LOCOMOTIVE ENGINEERS.—Saturday, January 25, at 2.30 p.m., at Caxton Hall. Extraordinary general meeting for consideration of alterations to Articles of Association, followed by Annual General Meeting and Presidential Address by Mr. Mervyn H. Ryan, C.B.E.

WOOLWICH ARSENAL.—In view of the recent correspondence in our pages, the following statistics showing the output of various units from Woolwich Arsenal, in July, 1914, and the monthly averages reached during the period of the war, will be examined with much interest:—

Manufacture.	July, 1914.	Monthly Averages Reached During the War.
Q.F. cases	4,600	253,300
Fuzes	3,700	375,000
Shells	7,250	147,900
Small arms ammunition	4,000,000	40,000,000
Friction tubes ...	27,500	360,700
Brass stampings ...	1,300,000	5,400,000
Brass castings (tons)... Filling.	72	390
Q.F.	39,000	1,043,000
Fuzes	7,150	1,903,000
Friction tubes ...	33,000	507,500

The higher figures are the average per month for twelve months. In addition to the above the number of railway wagons inward and outward per month rose from 1,600 to 26,000. The authorities at Woolwich may certainly be congratulated on these results.

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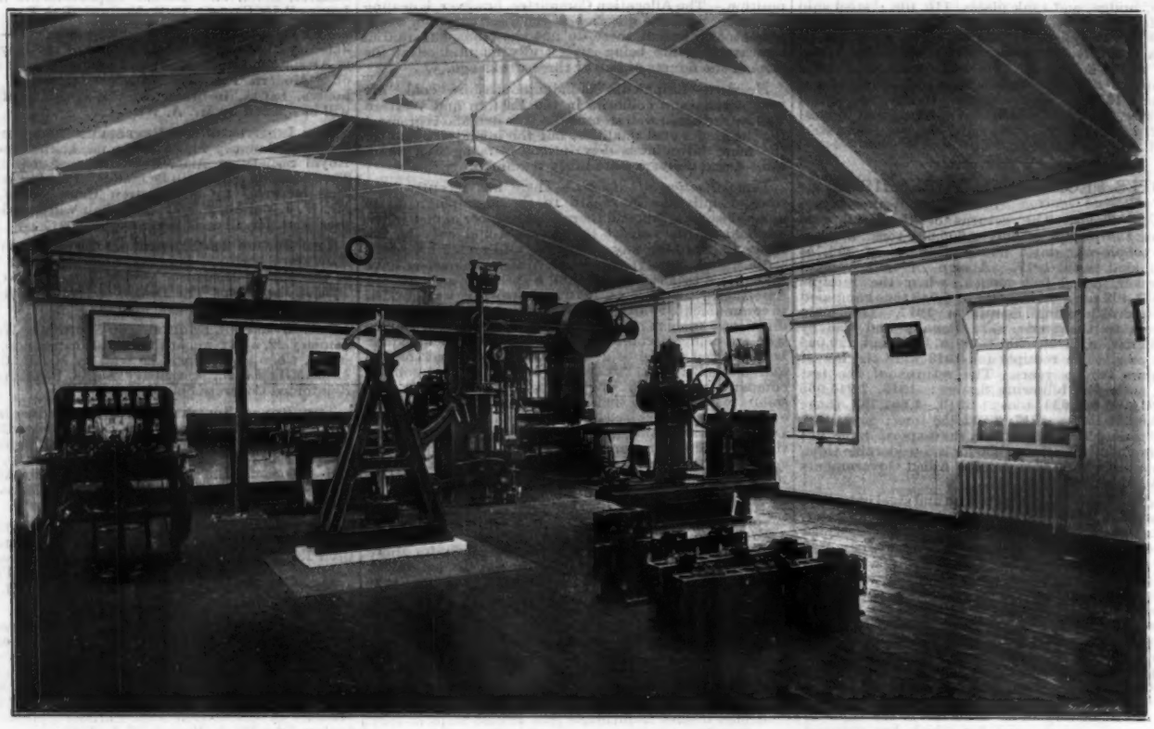

FIG. 9. THE MECHANICAL TESTING LABORATORY.

FIG. 10. CAPSTAN LATHE AND AUTOMATIC MACHINE SHOP.

THE BRITISH CHANNEL TRAIN FERRY STEAMERS.

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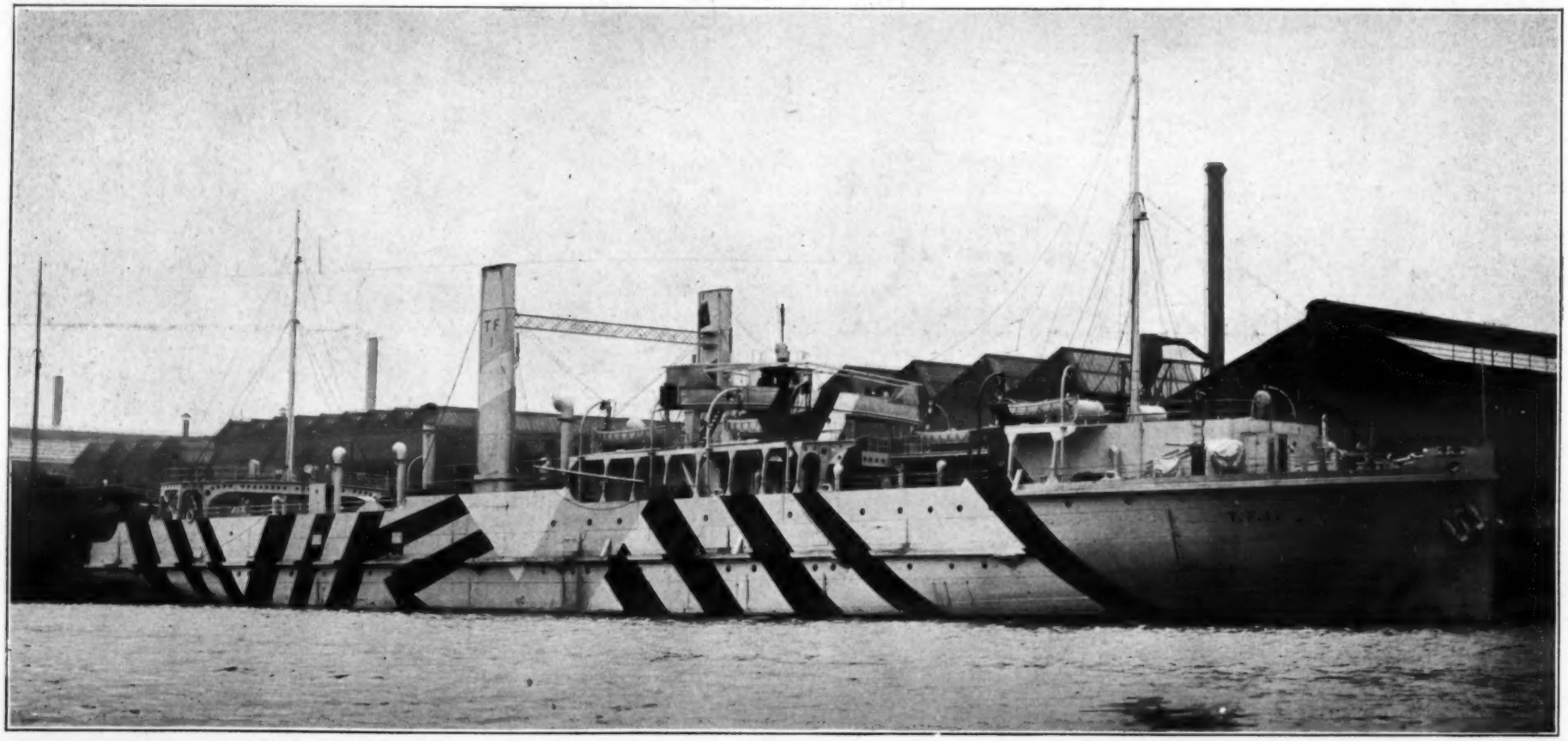

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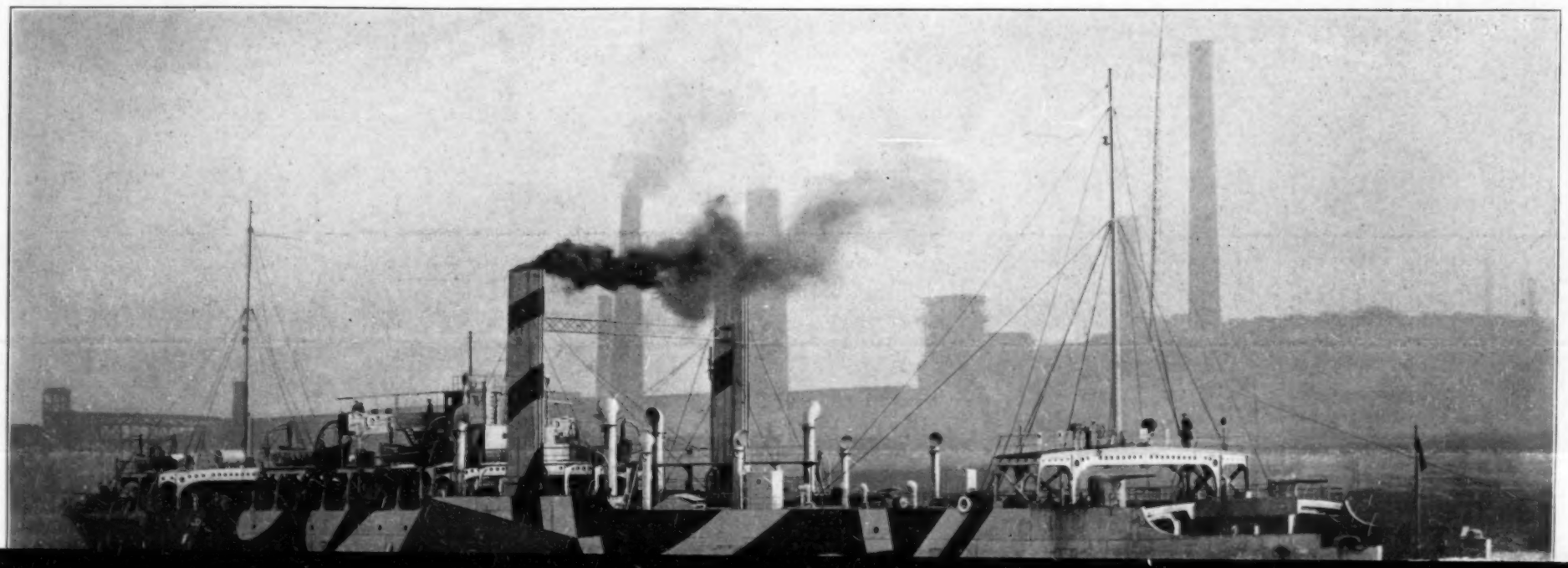

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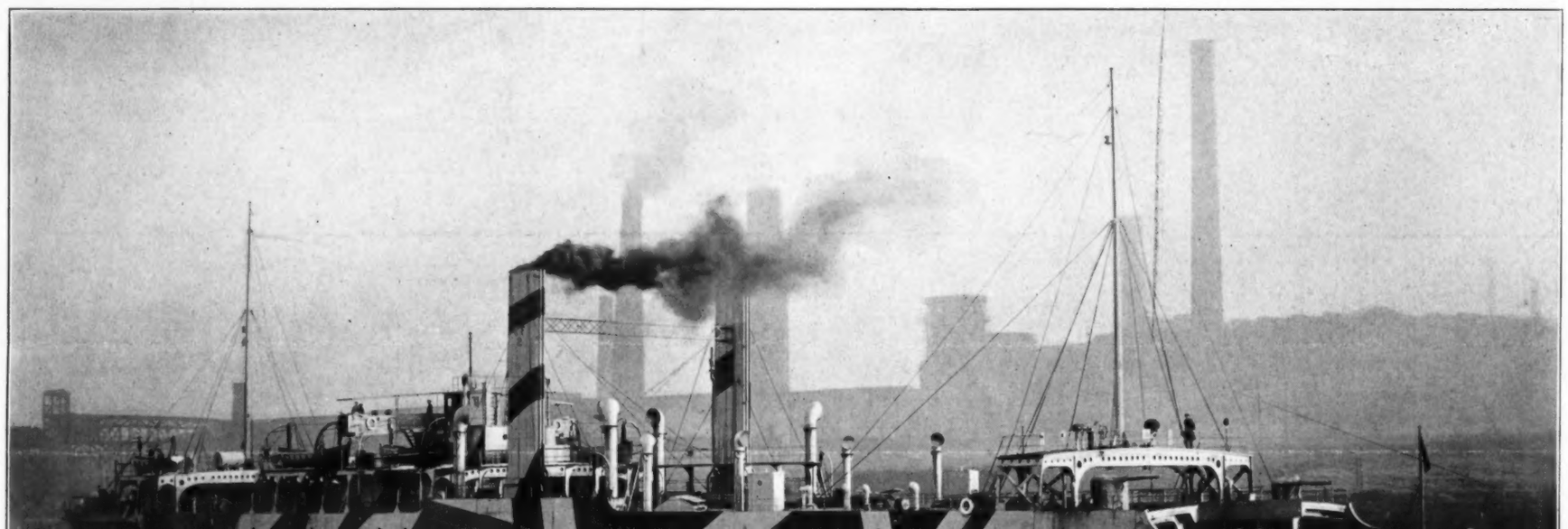

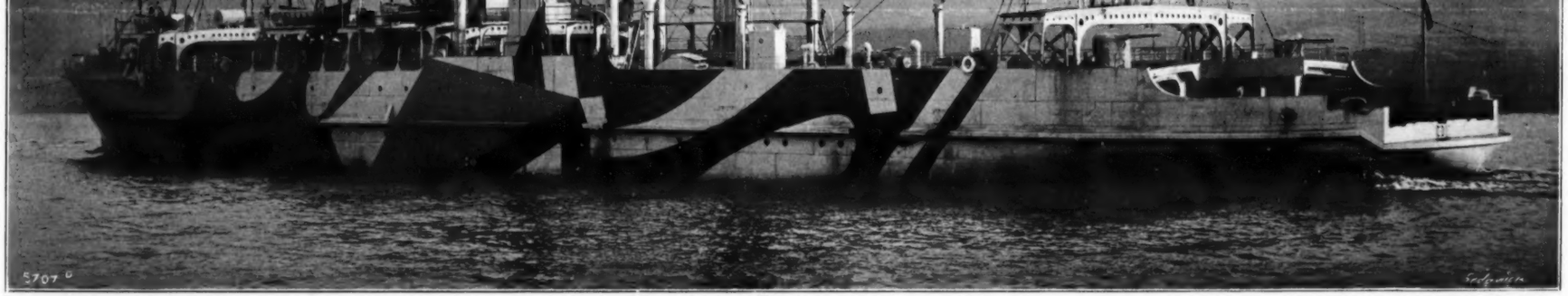

FIG. 2.

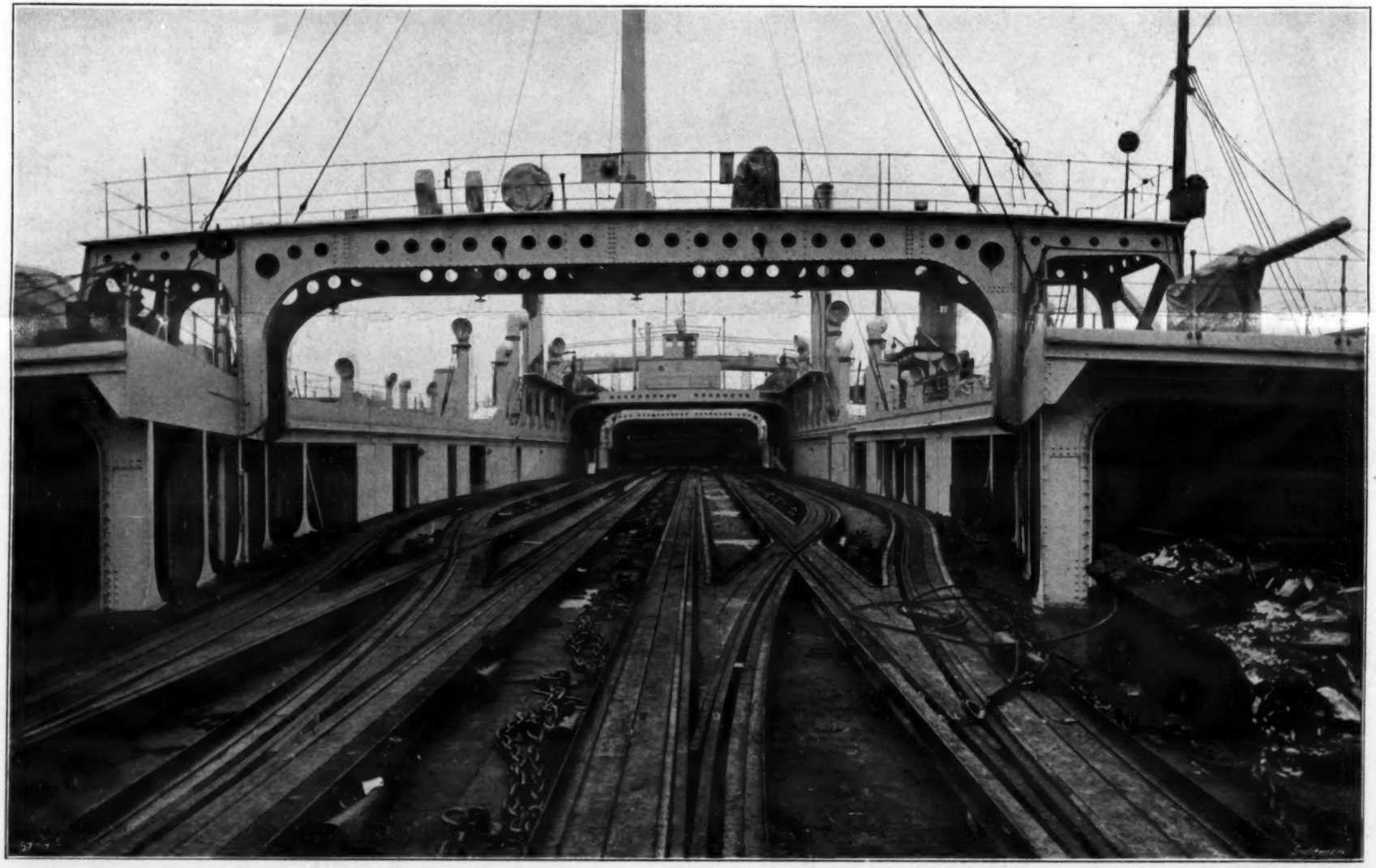

FIG. 3.

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Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than Monday morning.

SUBSCRIPTIONS, HOME AND FOREIGN.

REVISED RATES.

"ENGINEERING" may be ordered from any newsagent in town or country and at railway bookstalls, or it can be supplied by the Publisher, post free, at the following rates, for twelve months, payable in advance:—

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Thick ,, ,,	£2	9	6
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Thin paper copies	£2	9	6
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Foreign and Colonial subscribers receiving incomplete copies through newsagents are requested to communicate the fact to the Publisher, together with the agent's name and address.

All accounts are payable to "ENGINEERING," LIMITED. Cheques should be crossed "Union of London and Smith's Bank, Limited, Charing Cross Branch." Post-Office Orders should be made payable at Bedford Street, Strand, W.C. 2.

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We desire to call the attention of our readers to the fact that the above is our SOLE ADDRESS, and that no connection exists between this Journal and any other publications bearing somewhat similar titles.

TELEGRAPHIC ADDRESS } "ENGINEERING," WESTRAND, LONDON.
TELEPHONE NUMBERS—3863 and 8598 GERRARD.

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NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper and the consequent shortage of Supplies, Newsagents will not have copies for chance customers: therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 83.

ENGINEERING.

FRIDAY, JANUARY 17, 1919.

COLLECTIVE SYSTEMS OF PAYMENT BY RESULTS.

CONSIDERABLE extension of the systems of payment by results to the engineering industries has taken place within the last two or three years, largely as a result of the stimulus of war conditions, and the present is an opportune time to discuss the trend of such applications and to point out certain of the lessons of experience in operation. Systems of payment by results may conveniently be divided into two broad classes, the individual and the collective systems.

It has been proved repeatedly that in the operation of all systems of payment by results, considerable difficulties will early be experienced and the desired results will be seriously postponed unless the following three fundamental conditions are fulfilled. Firstly, that there must be a sufficiency of work, so that the increased output accruing from enhanced opportunity to attain to higher earnings can be accommodated. Increased output may mean that less men will be required for the work in view, and in such case provision must be made to absorb the surplus so created into other work, also carrying remuneration according to results. It has frequently happened that speeding-up has thrown men idle, and if not paid off, the argument is used that were normal conditions to operate, workers would be paid off. The consequence is a set-back to payment by results. Partly arising out of this condition, payment by results and time work should not be intermittent. This condition of partial application encourages dishonest booking of times against jobs, so falsifying records, and preventing in large measure the full benefits of payment by results from being experienced. Lastly, sufficient knowledge and experience must be available for and applied to the fixing of time-limits, piece prices, or standard outputs, which, when once fixed, must not be altered unless the conditions are changed. This last condition is obvious, but success depends very largely upon the application of such knowledge and experience as are generally available. Too generous an estimate leads to temptation to cut rates and so to restriction of output, causes dissatisfaction amongst neighbouring workers of equal skill, displaying similar application who, with a normal price, cannot earn so much. Tight or scant times and prices are equally bad, cause discontent and tend again towards restriction, since a worker, finding that a reasonable bonus cannot be earned, settles down in dissatisfaction to a minimum speed.

In many classes of work severe difficulties are encountered in the initial stages of introduction, and much care, study and patience should be exercised in making the change from time to piece or bonus work. In cases where the three leading conditions have not been sufficiently fulfilled, failure with individual systems has resulted.

With individual systems, it frequently occurs that a percentage of the workers in a shop, who may contribute in part to the successful earning of higher wages by those directly on payment by results, are performing work that cannot be accurately measured and so cannot be dealt with by an individual system. The foregoing considerations have been the cause of a considerable extension of the collective system, and in some cases of a change from the individual to the collective system.

The disadvantages of the individual system may be stated to be the amount of work and study involved in fixing up satisfactory standard times or prices for each job and for each individual worker. Furthermore, even with sufficiently accurate times or prices, a certain amount of friction is bound to be set up amongst workers by the fact that the relative capacity of individuals becomes apparent. With faulty rate-fixing the consequences are obvious.

One of the greatest difficulties in practice in the operation of the individual system of payment by results is, as already mentioned, the difficulty of extending an individual system to cover all the workers in any shop. The individual systems of payment by results are well known and have been sufficiently often described to warrant the omission of further explanation. Under the heading "individual systems" are included cases where a number of workers are of necessity engaged in a squad, gang or group upon one job, and where the job is not split up into small components.

The demarcation between individual and collective systems depends in fact upon the extent to which the work is split up. Where a few workers of the same trade work together on a job, at a fixed time or a price, it is not a collective system, but, if the job of building an engine or a set of boilers be given out to a large squad of men perhaps of various trades, it becomes then a collective system. Collective systems have not received the same attention as individual systems. They may be divided into three broad classes. Firstly, where a contract for a certain sum of money, or so many hours, is given to a relatively large number of workers of various trades for carrying out a definite and considerable amount of work sometimes known as the "Contract piecework system." Secondly, where so much bonus or money over and above the time rate is paid to a large number of workers, or to the whole shop, according to the amount of work turned out by this number of workers, or by the shop in a given time. Thirdly, that of profit-sharing. At the present time, we may remark, except in certain cases of piece work, the time rate of wages is customarily guaranteed.

It will be seen that these collective systems of payment by results eradicate certain of the disadvantages of the individual system, in that the whole shop can be given an incentive towards increase of production. One disadvantage which will immediately occur, will be, that whereas with individual systems certain highly skilled workers are encouraged and rewarded according to their skill, with the collective system the encouragement is much less direct. Also, the average worker has not the same incentive to speed-up as with the individual system, and the best that can be advanced for the collective system is a general levelling-up.

With collective piece work or contract piece work, the contractor will wish to choose the men with whom he will work, which will tend towards the elimination of the less efficient workers; and the functions of the contractor will become, in large measure, those of management, in that he will be interested in the supply of material, and the progressing of work in stages preliminary to his contract. These considerations will naturally become diverted from the foreman or from the management to this contractor. This is not stated necessarily as a disadvantage, but simply as a consequence.

To turn, however, to those systems where the whole shop is working under a collective bonus scheme, this bonus can be paid in two ways. One, when so much per cent. over the time rate is paid to every worker for every unit of production turned out per unit of time; and secondly, where so much money is paid in total wages, or so many total hours are allotted to each unit of production and all the workers share in proportion to their time rate, either totally or partially, according to any scale (such as the Halsey, Rowan, &c.), any saving in time or money over the standard hours or price. The first system is obviously wrong. It means that even should a shop be working at only 25 per cent. efficiency, some work is being turned out and some bonus over and above the time rate falls to be paid. The second system is correct, in that the fewer the workers' hours per unit of output, the larger the bonus per hour per worker. This latter system has

been much advocated and extensively adopted in shell and munition works, and has undoubtedly achieved considerable success.

The fixing of the collective output bonus appears much simpler than the rate-fixing required with an individual system. With a collective system the basis is generally to pay bonus in proportion to improvement on past performance, without due consideration to the measure of the efficiency of such performance. It is exceedingly difficult to measure the efficiency of a shop without that detailed investigation required by the individual system. With individual systems errors tend to correct themselves. With the collective shop system the error may be much greater. Where practice has been imperfect in the past, it is possible so to fix an output bonus with the collective system, that large wages will be paid, without the requisite rate of production or overall efficiency having been approached, albeit a big improvement on past performance has been achieved. In other words, a proportion of the workers are giving considerably less than 100 per cent. output and will take the same percentage bonus as the best worker. The writer has seen collective bonus shops where considerable bonus was being earned, and where on some sections of the machines a proportion of the workers were required to do very little work. Such a state of affairs would not be so readily possible in the case of the individual system, if properly administered, where times, rates and bonuses are not calculated merely in relation to past performance, but where due regard is given to the output that should be possible of attainment.

The collective system is popular with the workers, and this is its greatest asset. It is the purpose of these short notes to issue a warning against the complacency with which the improvement resulting from the introduction of collective bonus is generally regarded and to insist on the necessity of that careful individual investigation—inseparable from the best operation of the individual system—in order that we may correctly assess our efficiency performance not in regard to the past, but relatively to and only to the best of which we are capable.

FRANCE AS AN IRON AND STEEL COUNTRY.

ON the eve of the war France was making 5,000,000 tons a year of pig-iron, with steel in proportion, against our 9,500,000 tons, and Germany's 19,000,000 tons. It is now estimated by some authorities that France will soon be making 13,000,000 tons a year of pig-iron, with steel and engineering products in proportion. This would substitute France for Germany as our leading Continental competitor in the iron and steel trades. We should have no cause for regret if this were so; but there is apparently some misconception existing in regard to France as a commercial rival. In any case, however, the industrial face of Europe is being changed, and a brief review of the possibilities, as seen through French eyes, may be offered.

A prominent French mining engineer, M. Ch. Marquet, in a series of articles contributed to *L'Information*, emphasises the striking industrial and commercial significance of the restoration to France of the iron fields taken by Germany in the seventies. He predicts that the German pig-iron output, which was 19,000,000 tons in the last twelve months before the war, and was rapidly growing, will fall to 15,000,000 tons, whilst that of France will be increased from 5,000,000 tons to 13,000,000 tons. The restitution of Alsace-Lorraine puts France once more in possession of the finest iron ore basin in Europe, with the addition of the Lorraine iron and steel works. The iron basin of what is called French Lorraine covers 150,000 acres. The deposits are estimated at 3,000,000,000 tons. German Lorraine has an ironfield covering 98,000 acres, and is estimated to contain 1,830,000,000 tons. With the occupation of the whole of Lorraine, plus the existing French deposits, France will own over 5,000,000,000 tons of iron ore. Germany will be left with 1,777,000,000 tons; Britain possesses, it is calculated, 1,300,000,000 tons. Sweden comes next in Europe with 1,158,000,000 tons. The loss of Lorraine means to Germany the loss of one-half of her iron ore.

Between 1900 and 1913 the output of French iron ore mines increased from 5,500,000 tons to 21,500,000 tons. The make of pig-iron increased from 2,000,000 tons to 5,000,000 tons. About 90 per cent. of French ore mined was raised in the Meurthe and Moselle region. Out of the 21,500,000 tons mined in 1913 in France, 9,500,000 tons was exported. France imported 1,500,000 tons, leaving a net exportation of 8,000,000 tons. The chief reason given why France did not smelt the whole of the ore she raised is that she was dependent very largely upon other countries for the necessary coke. Germany alone supplied 2,393,000 tons of coke in 1913. The French were compelled to supply ore to Germany in order to obtain coke. The French could only increase their own production of iron and steel on condition that they sent increasing quantities of ore to feed the furnaces of Germany.

The return of Lorraine, observes M. Marquet, will bring an addition of, say, 20,000,000 tons of ore annually; but only an insignificant quantity of fuel. A return to the former dependence on Germany for coke is out of the question. The Peace Treaty must liberate French industry from tutelage in regard to coke. The necessary guarantee may be obtained by the ceding the coal basin of the Saar to France for the use of the Lorraine works. Even this would only partly compensate France for the damage done by the Germans.

M. Marquet predicts that France will produce as much as 40,000,000 tons of ore annually, and work this up when the necessary blast furnaces are built. Hitherto the bulk of French production has been consumed at home, but with an annual output of anything like 13,000,000 tons of pig-iron, which may mean 11,000,000 tons or 12,000,000 tons of steel, there will eventually be a large surplus available for export. In 1913, French exports were only 321,000 tons of iron and steel semi-products. After making good the war damages the French will have to look abroad for markets. In order to export France must provide means of transport between the producing regions and the ports, the existing railways being badly adapted for this traffic; the ports will also have to be equipped; and a mercantile fleet will be necessary.

Viewing the matter from a purely British standpoint we may observe that the substitution of French for German competition, so far as the exploitation of the Lorraine ore fields is concerned, will be an advantage to us, no matter how energetically our friends may work and trade, whilst the probability is that the French will never operate the industry on anything like the fierce, competitive lines adopted by the Germans. We may take it for granted that the Germans will be compelled to yield all, if not more than all, they took from France in the seventies, and that our friends will industriously work the natural resources involved. But the demand for iron and steel will be so great for many years, in order to make good the damages and wastages of war, and the great arrears due to the war, that there is no immediate prospect of any keen competition between the producing nations. In the next place, when at length competitive conditions do come into play, we cannot anticipate anything but fair trading from the French. The German syndicates supplied coal and ore below natural cost to manufacturers engaged on export orders. The State carried the products on its railways and canals at half the ordinary rates, and paid subventions to the ships taking the goods abroad. With the Lorraine ore fields in French hands they may be industriously exploited, but the resultant products will not be extravagantly subsidised for the purpose of underselling us in the world's markets.

THE RAILWAY PROBLEM.

EVERYTHING that has happened since we commenced [ENGINEERING, December 20, 1918] this series of references to the railway problem has demonstrated the correctness of our opinion that it is desirable for the Government very carefully to consider the whole matter before committing the country to a nationalisation scheme that may have consequences far different from what may be anticipated. The business community is awakening to the seriousness of the situation, and we have no doubt that their views will be properly represented. To note one or two facts, we observe that the Glasgow Chamber of Commerce has decided that "nationalisation [of railways] would be a national misfortune." The Birmingham Chamber of Commerce has come down on the side of opposition to nationalisation; while most important of all are the resolutions passed recently at a conference of the Federation of British Industries. At this conference there were representatives of the Association of Chambers of Commerce of the United Kingdom, Mansion House Association on Railway and Canal Traffic, Traders' Traffic Conference, London Chamber of Commerce, &c. Here are the resolutions that were passed:—

1. The manufacturers and traders of the country, in agreement with the view expressed by the Prime Minister of the importance of expeditious and economical transport to the trade of the country, desire to assure the Government that it may reckon upon the co-operation of the business community in any well-considered proposals to add to and to improve the transport facilities of this country.

2. That before the country is committed by the Government to any change of policy in regard to railways, it is desirable that the Royal Commission appointed some time since to consider the question should complete its investigation, or that a Select Committee should be appointed to continue the inquiries commenced by the Select Committee of last year, and that such report or reports should be available before action is finally taken by the Government, and that it be an instruction to such Royal Commission or Select Committee that its report should be available by June 30 next.

3. That this meeting is unanimously opposed to nationalisation of the railways, and considers that in any form of control which it may be decided to adopt the Government should not in any case be concerned with the detailed administration of the railways of the country.

4. In the opinion of the bodies here represented it is desirable that the powers of the present Railway and Canal Commission Court should be extended and be vested in a board of control, consisting of persons of experience in matters pertaining to transport, and that the majority of these persons should be appointed by the Secretary of State for the Home Department from a list submitted by a joint committee of representative associations concerned with trade.

5. That pending other arrangements being made by the State with the railway companies, the State should continue its present guarantee to the railway companies controlled by it.

6. That this meeting is of the opinion that the Government should be asked to instruct the Railway Executive to remove the many restrictions imposed, and reinstate all facilities withdrawn during the war.

We have already suggested that the Royal Commission on Railways, which was appointed in 1913, should complete its investigation, and we propose to give reasons for that line of action. The most important is to secure as impartial a statement of fact as can be obtained. That there are many things connected with British railway practice and administration that call for amendment is certain, and it was to put some of them right that the Railways Bill of 1912 was drafted. That Bill was not passed, and it was considered to be desirable to have the whole railway position investigated. As Mr. Buxton said in October, 1913, his experience as President of the Board of Trade had continually and continuously confirmed the view that all was not well between the railways and the traders and the community. But the Government had come to the conclusion that, without the authority and information which an inquiry alone could give, they were not on sufficiently sure ground to deal adequately with the problem. Hence the appointment of the Royal Commission—whose terms of reference were drawn so wide that it would be "able to deal with every aspect of the problem"—even including whether the State should itself undertake the responsibility. It may be urged that what has happened during the war has altered the whole aspect of the matter. We do not agree. As we have endeavoured to show, there has been no material change in the operation of the railways. The control by a Committee of General Managers has really resulted in freeing the railways from the "blighting effect" of State control, and the successful operation of British railways during the war is really a tribute to the efficiency of private (as distinct from State)

ownership. The Select Committee on Transport has reported that the changes in the organisation and practice of the railways have been less than is generally supposed. "The desire has been to get the work done with as little disturbance of the existing machinery as possible. As a result, the individual organisations of the railway companies have remained intact, and the Boards of Directors have continued to be responsible for the conduct of their affairs. The changes which have been introduced and the high efficiency which has been witnessed in the working of the traffic by the railways during the war, have been due far more to a patriotic determination on the part of all concerned to do their utmost to assist the country in a time of national emergency, regardless of corporate or personal interests, than to the direct imposition by the Government of its will upon the railway companies. The Government was not, and is not to-day, organised to carry on the administration of railway systems by means of the direct control of a Government Department." We believe this to be a most accurate statement of fact—yet the excellence of the results of railway operation by the companies' officials during the war is now urged as a reason for imposing Government control by a new Ministry, and we hear in various directions of the inclusion in the Government of railway experts, notwithstanding that they had nothing whatever to do with the hard problems that had to be solved by the railways in this country. In this connection, we may call to mind the fact that Sir Eric Geddes, who was called upon to overhaul the transport arrangements in France, demanded from British railways hundreds of locomotives and thousands of wagons to assist him in relieving the position in France. What his demand meant in the way of added difficulties on this side, where the railways were handling—with a depleted, inexperienced staff—more traffic than ever before, has never been recorded. It is known that the locomotives and wagons *were* despatched, yet British railways continued to be operated satisfactorily. To again quote from the report of the Select Committee: "The success that has attended the operation of the railways throughout the war, which has been superior to that witnessed in any other of the belligerent countries, affords conclusive proof both of the adequacy of the arrangements which had been made in advance, and of the capacity of those who have been concerned with their execution." We suggest that Sir Herbert Walker and his colleagues on the Railway Executive Committee have been altogether too modest, and it is high time they took steps to let the public know what they have done. Otherwise they may find that the gratitude of the Government has found expression in the appointment of a more pushful individual as Minister of Railways!

We fear that we have somewhat digressed in our desire to demonstrate the need now—as in pre-war days—for a full inquiry into the railway problem. The Government were then not on sufficiently sure ground to deal with the problem, neither are they now. The Select Committee on Transport, to whose report we have already alluded, cannot be regarded as having sufficient weight. Its proceedings were private* and admittedly incomplete, although its "preliminary conclusions" would, doubtless, be of some assistance if placed before the Royal Commission. They were: That the organisation of the transport agencies of the country—and particularly of the railways—cannot be allowed to return to its pre-war position. That the temporary arrangements for the control of railways and canals during the war would not be satisfactory as a permanent settlement. That unification of the railway system is desirable under suitable safeguards, whether the ownership be in public or private hands. Any one of the following courses would be consistent with these conclusions, but the Committee "is not in a position to recommend which of these methods should be adopted in the first instance":—

1. Further amalgamations of railway companies as a step towards unification.

2. Unification accompanied by private ownership and commercial management.

3. Unification by means of nationalisation, followed by:—

(*a*) Establishment of a Government Department to manage the railways.

(*b*) Constitution of a Board of Management not directly represented in Parliament.

(*c*) Leasing of the system to one or more commercial companies.

Clearly, this recital of alternatives does not assist a solution of the problem. As we have said, the report might be of assistance to the Royal Commission; so also would the various reconstruction reports, *e.g.*, on agricultural policy, shipping and shipbuilding industries, &c., that have contained more or less extensive references to transport matters. All of them require to be welded into a complete statement leading up to logically-expressed conclusions. Similarly, it is desirable that the various allegations against the railways and criticisms of their shortcomings and imperfections should be publicly stated and considered. Of late there have been numerous and, we are bound to say, rather irresponsible statements. Even the Prime Minister is reported to have said that "foreigners got their produce to the English markets more cheaply and more speedily than our own farmers." This is a reflection upon British railways, which, if substantiated, would render them liable to proceedings for undue preference, and is in striking opposition to the report of the Departmental Committee on Preferential Treatment of 1906 [Cd. 2959]. That Committee "cordially admitted the generous offers and efforts made by most of the great companies to stimulate local agricultural trading—offers and efforts which have met with but very scanty recognition." They further agreed that the local trader cannot expect for small, irregular, and often ill-packed consignments, the same rates and facilities as are given to the large, regular, and well-packed consignments with which he is in competition, and, in order to claim comparatively equal rates and facilities, he must organise something like a reasonable approach to the conditions under which the competing trade is carried on. This, however, is merely cited as one of many questions that could be ventilated before a Royal Commission, but could not be effectively disposed of in a debate in the House of Commons. But there are other matters: the whole basis of railway rates and charges requires to be overhauled, and a new, simplified classification prepared; the procedure for dealing with complaints by traders should be amended and the Board of Trade given extended powers; and the procedure of the Railway Commissioners' Court cheapened. The attitude of the railways to organised conferences with traders and traders' associations requires to be more fully explained, in view of the pre-war impression that some of the larger railways were disposed to favour something of the kind. Then there is the question of through rates and the means of securing that small lines—as was recently shown in proceedings affecting the North Staffordshire Railway—do not demand too great a share of a through rate.

The question of how British railway rates really compare with foreign railway rates also calls for elucidation, in the light of incomplete comparative statistics, different conditions in respect of amount of traffic, length of haulage, and services rendered by the railways in the countries with which comparison is made.

Now, much evidence has been given before Lord Loreburn's Commission by representative men, associations, &c., and Sir Charles Owens has stated the case for the railways. But it is known that there were other witnesses to be heard; if the sittings were now to be resumed, important supplementary evidence might be given arising out of what has happened during the war. In particular, full and accurate information could be published as to the precise extent of traffic handled, expenses incurred in respect of concessions to the staff, and payments by the Government for the use of the railways. The dangers of nationalisation might be ascertained in respect of (*a*) political pressure by the employees, and (*b*) abuse of railway facilities by Government Departments, who during the war have had the right of transit for men and goods without a separate charge, leading to excessive use of free or cheap-fare vouchers, &c. Last, but not least, attention should be given to the question whether revenue—apart from payments by the Government—is insufficient to meet expenditure plus interest on capital, and, if so, what increase of charges would be necessary to make income and expenditure balance without subsidy. All this does not mean any delay worthy of consideration in comparison with the magnitude of the problem. The Government will be engaged for some time on the Peace Conference; let them use the time by prolonging the present temporary control of railways through the Executive Committee, and reconstituting the Royal Commission on Railways as suggested by the Federation of British Industries. If this is not done; if a hasty decision is come to largely, if not wholly, on political grounds, the business community, and, indeed, the public at large, may have cause to regret. Let it not be forgotten what nationalisation has already meant in this country. The Committee on Retrenchment in the Public Expenditure has placed on record the statement [Cd. 8200] that they "have been impressed by the fact that, of all the numerous services managed by the Post Office, hardly one shows any profit, except the letter post. The history of the telegraphs is most unsatisfactory," and, as regards telephones, "The profit now derived from the whole system appears to be less than the payment which the National Telephone Company used to make by way of royalty to the State." This should give pause to any ambitious politician who would nationalise the railways, and the business community must see to it that the matter is not rushed through a too-obedient Parliament.

* Since the above was written the evidence given before the Select Committee has been published, and in due course will be reviewed in these columns.

IMPROVEMENT IN THE MERCHANT SHIPPING SITUATION.

LLOYD'S return, just issued, shows that at the end of the year there were in course of construction in the shipbuilding yards of the United Kingdom 424 vessels, aggregating 1,979,952 tons, which compares with 383 vessels of 1,746,933 tons at the end of September. This shows an increase of 233,000 tons. When compared with the total at the end of 1917 the increase is not so great, but it should be borne in mind that at the present time an enormously greater number of workers are engaged on merchant ships than was the case a year ago, warship building having been reduced to the extent that only vessels far advanced are now being completed. This is established further by the fact that the ships launched during the last quarter of the year total 83 of 397,186 tons, as compared with 67 vessels of 256,984 tons in the quarter ending with September. Again, there were laid down in the last quarter of the year 117 vessels of 551,701 tons, as against 90 vessels of 344,971 tons. If, then, the workmen are available, and if they do their best to advance the ships on the ways, the output of British tonnage should quickly exceed the maximum output of any previous period in the history of the industry. That this is desirable it would be easy to establish, but there is no need to enter into the question.

The increase of the work in progress, as compared with the figures for the end of September, applies specially to Belfast, where the increase is 80,000 tons; to the Tees, with an addition of over 16,000 tons; to the Tyne, with an increase of nearly 48,000 tons; to Sunderland, with an increase of 23,000 tons. In the case of Glasgow it is surprising to note that the increase is barely 13,000 tons, while at Greenock there is an actual decrease. It is further noteworthy that at Barrow the merchant shipbuilding has gone up from 6,380 tons to 25,880 tons, indicating a quick transfer from naval to merchant shipbuilding.

In this connection reference should be made to the highly commendable arrangement with the Chamber of Shipping regarding the vessels for which contracts were made with shipbuilders by the Government. Two of our most prominent shipowners, Lord Inchcape and Sir Owen Phillips, who are at the head of two of the largest shipping companies, have, in association, entered into an agreement with the Controller of Shipping, acting for the Govern-

ment, to take over the contracts made for the building of about 130 standard steamers, representing a sum of nearly 20,000,000*l*. In this they have been actuated purely by patriotic motives, as it is their intention to have associated with them any British shipowner who desires to acquire tonnage. They have invited such shipowners to communicate with them not later than the 24th inst., and to them they would give particulars of all the standard ships now building. They say: "Any vessel or vessels transferred to a shipowner will be made over on the same terms as those agreed with His Majesty's Government, and the vessels will be distributed as far as possible on an equitable basis having regard to the losses sustained by the owners through enemy action." Lord Inchcape, speaking for himself and Sir Owen Phillips, states that it is not their intention to make any profit for themselves or their companies by the purchase, or to benefit the companies with which they are associated in the distribution of the ships, either in the matter of class or time of delivery, but they retain absolute discretion with regard to allotment, so as to avoid any dispute or question. As soon as the transactions are completed, a statement is to be sent to each purchaser, certified by a chartered accountant, showing the intromissions of the operation. This will have an important effect in re-establishing the shipping industries of the country, as the vessels purchased are not to be subject to requisitions on blue-book terms. If, however, the Government require to charter any of the vessels for national purposes the terms of charter will be matter for mutual arrangement. Otherwise the vessels will pass into the British mercantile marine, and be under the direction of their owners, a state of affairs which gives promise of early return to normal shipbuilding conditions.

As regards the situation in other countries, the total under construction in the United States has, in the three months, gone up from 3,382,709 tons to 3,645,919 tons. The number of ships, however, is less, which would indicate that the ships recently laid down are of larger size. Of the total of American ships building now over 1,000,000 tons are wooden vessels, and half of this shipping is in course of being built on the Pacific Coast, where altogether there are 1,257,490 tons in course of construction. On the Atlantic Coast, however, steel tonnage enormously predominates, the total being 1,699,656 tons. Of this latter total only 205,160 tons are of wood. As compared with the preceding quarter, there is a very considerable decrease in the wooden ships being built in the United States. It is very significant of the situation that of the total tonnage at present under construction in allied and neutral countries—in all, 4,942,037 tons—the tonnage of wooden steamers represents 1,153,588 tons, which is very abnormal. In the case of the United Kingdom only 1,240 tons represent timber ships out of a total of 1,979,952 tons. One further interesting fact is that only 4 of the 424 vessels exceed 20,000 tons, while the number exceeding 10,000 tons is 12.

NOTES.

THE RESCUE OF THE CREW OF THE "K. 13."

THE Censor has now permitted Mr. Bennet Copplestone to publish in the *Cornhill Magazine* some particulars of the rescue of the crew of the submarine K. 13, which by inadvertence at the end of her reception trials, was submerged with her ventilators open, swamping the craft so that she was unable to rise again from the bottom of the Gareloch. The K. 13 was of 2,000-tons displacement, and was fitted with steam turbine machinery for surface propulsion. She had two funnels, which, like the boiler-room ventilators, were large openings which had to be made tight by covers before submerging. The trials were carried out on January 29, 1917, and were fully successful, and the craft, before returning to dock was accepted by the Admiralty officials. Following this, the commander in charge decided to take still one more dive. The order to close down was, however, incompletely executed, and the ventilators were wide open when the K. 13 submerged. Water poured in through these, drowning the engine and boiler-room crews. The bulkheads saved the rest of those on board for the time being, but they were in a most dangerous plight, as it was impossible to regain the surface. Two officers, Commander Goodheart and Commander Herbert, attempted to leave the craft by the conning tower hatch, so as to give information as to the conditions below to those engaged in the work of rescue. The scheme was to enter the conning tower, secure the lower hatch, and open the sea cocks. The water which entered compressed the imprisoned air, and rose to the shoulders of the two adventurers. Further compressed air was then let in from below, and the upper hatch bolts released. Commander Goodheart stepped under the opening and was carried out by the rush. He was, however, caught and held under the chart house, and drowned. Commander Herbert was more fortunate, and reaching the surface was able to give very valuable information to those engaged in the rescue operations. Immediately knowledge of the disaster was received Fairfield's commenced to prepare two tubes, one of which, a flexible tube 7 in. in diameter, was intended to supply air and food to those imprisoned, the plan being to screw the pipe into the circular ammunition hoist opening beside one of the deck guns. The other pipe, built up of steel plates and shapes, was intended to fit over the torpedo hatch, and provide a means of egress. In the meantime the salvage ship *Ranger*, under the command of Capt. Young, had been telegraphed for from Liverpool. The plans in progress were communicated to the imprisoned crew by Morse signalling. The accident occurred on the Monday, and it was 8 a.m. on Wednesday before the air-tube connection was made good, and fresh air admitted again to the interior of the K. 13 after a submersion of 40½ hours. The *Ranger* arrived on the Wednesday afternoon. The hawsers available proved too light to raise the vessel completely, but her bow was brought above the surface. A hole was then cut through both platings by the oxy-acetylene process, and through this the 49 survivors were finally released, after an imprisonment of 54½ hours. Twenty hours later the hawsers parted, and the submarine sank again to the bottom of the loch.

A PEACE OPPORTUNITY.

It is increasingly evident that, due to the finish of the war, opportunity is knocking at someone's door. To realise this it is only necessary to peruse the advertisement columns of the daily and industrial press. Firms are desirous of manufacturing specialities, preferably patented, and are more than willing to consider novelty of utility devices. The outbreak of war meant that large numbers of promising inventions passed into oblivion. The first effect was to button up the pockets of the enterprising to the great disadvantage of the inventor, who had perforce to abandon any efforts to market his ideas. Now that peace has returned the converse effect is already with us. Faced with the immediate and total cessation of the munitions of war, with capital sunk in plant and organisation, there is an unexampled opportunity for those with inventions or ideas to market. We have more than once called attention to the fact that inventors have received no consideration whatever at the hands of the Board of Trade. Those who secured a patent in the six or twelve months preceding August, 1914, have had to pay the usual fees or forfeit protection. It may be urged that these are not inordinate, but the first and second renewal fees added to agents' charges and the prolongation of the war, have led to the forfeiture of some thousands of patents. The Comptroller should have been given power to postpone the first renewal fee until six months after peace. As it is, the object of patent rights in the protection of ideas on the part of those not over-blessed with this world's goods, has been clearly frustrated. The resumption of normal conditions has set a premium upon likely manufactures of protected type, and without a doubt numerous patents forfeited by reason of the circumstances named will be worked without return to the originator. It is very unlikely that any retrospective steps will be taken to give validity and protection to any device which now comes on the market. Still the time is ripe for extension of the term enjoyed in the life of the patent, where a valid plea can be advanced that this has been restricted by the circumstances of the war. The fact remains that the present is the inventor's opportunity. In place of being interviewed as a favour and every opposition raised to his device, he is being implored and solicited to produce his idea, and he may be assured of every consideration by those with plant and little to make. Even the working of lapsed patents may produce some compensation. Although there will be no legal instrument to sell or royalty to exact, it is more than possible, if due precautions are taken with a reputable firm, that some solatium will reward the originator who is willing to give assistance in working out details. Invention is always a gamble at long odds. In some respects patents hamper industry, yet the world would be collectively the poorer if there were no stimulation of new ideas. The agitation for a lower scale of fees promises to be successful. The country requires all its brains in the next few years, and lessened patent charges—which need not be unremunerative to the State—is one of the easiest methods to put a premium on the ingenuity so badly needed. So occurs one of the opportunities of peace. The atmosphere is kindly toward industrial betterment, and this is much more than the provision of canteens.

COMMERCIAL ADVERTISING.—"Methods and Applications of Commercial Advertising" is the title of a series of six lectures at the London School of Economics and Political Science (University of London), Clare Market, W.C. 2, to be delivered at 7 o'clock on Thursday evenings, beginning January 23. The lecturer is Mr. Thomas Russell, president of the Incorporated Society of Advertisement Consultants, formerly advertisement manager of *The Times*. The lectures are intended for practical advertisers, advertising agents and their staffs, and the half-guinea ticket for the series can be obtained of the secretary at the school.

NON-FERROUS METAL INDUSTRY ACT, 1918.—The Board of Trade draw the attention of all companies, firms and individuals dealing in non-ferrous metals to section 10 (2) of the Non-Ferrous Metals Industry Act, 1918, which provides that the Act shall continue in force for a period of five years after the termination of the war. The provisions of the Act are in no way affected by the relaxation of the control over certain non-ferrous metals exercised by the Ministry of Munitions during the war; and it is still necessary for companies, firms and individuals doing business of a kind to which the Act applies to be licensed by the Board of Trade.

CONTRACTS.—Messrs. Dick, Kerr and Co., Limited, have recently secured a contract for the supply of a 3,000-kw. 3,000-r.p.m. turbo-alternator set, together with condensing plant, to Messrs. Cammell Laird and Co., Limited. The turbine will be of the Willans-Zoelly type, to operate on steam at 160 lb. pressure, superheated to 650 deg. F.; the condensing plant is of the surface type, with the Willans' rotary system of air extraction, the circulating, ejector and extraction pumps being driven by an auxiliary turbine, which will exhaust into a feed heater. The turbo-alternator, by Messrs. Siemens, will supply three-phase current at 3,300 volts. 50 cycles, and will be fitted with an overhung exciter.

IMPORTS IN ITALY OF AGRICULTURAL MACHINERY.—The following, according to information supplied to H.M. Commercial Counsellor in Rome, were the annual importations of agricultural machinery into Italy before the war, and the share of the chief competing manufacturing countries. *Ploughs*:—Three-fifths from Germany, one-fifth from Belgium, and the rest from America and France, out of a total of 35,000. Mechanically-drawn ploughs were imported entirely from England. Those employing the wire-rope system were constructed in Italy. Motor ploughs were unknown in Italy before the war; those imported since have been almost entirely of American construction. *Machines for sowing*:—Importations numbered about 1,000; two-thirds from Germany, one-third from the United States of America. *Thrashing machines*:—Four-fifths of these were imported from England. *Harvesters*:—About 1,200 reapers and binders, 6,000 mowers, and 2,000 other harvesting machines, with the exception of a few from England, France and Germany, were almost exclusively imported from the United States of America. *Machines for viticulture*:—These were almost all imported from France. A considerable quantity of ploughs were manufactured in Italy, perhaps 10 per cent. of the number imported. *Motor machines*:—Motor machines of original designs were being made, in no way inferior, though more costly, than those of foreign design. *Harrows*:—Except the disc type and spring cultivators (*coltivatori a molle*) which were imported, the former from America, the latter from France, harrows in use were almost all made in Italy. Italy produced about one-tenth of the number of portable engines and thrashing machines imported. It is thought that, as has indeed been shown during the war, there are no difficulties of a technical character in the way of native construction of all this class of machinery.

INDUSTRIAL NOTES.

AT a conference, held in York, last week, the question of a new agreement to supersede the one arrived at on December 20, 1917, between the National Engineering Employers' Federation and the trade unions, concerning the conditions to govern works committees, was considered. The Amalgamated Society of Engineers was not represented. The following trade unions had sent representatives:—The Steam Engine Makers' Society, the National Union of General Workers, the United Machine Workers' Association, the United Kingdom Society of Smiths and Strikers, the Amalgamated Society of Core Makers, the United Coppersmiths' Association, the National Amalgamated Union of Labour, the Electrical Trade Union, the Amalgamated Tool Makers, the Workers' Union, the Association of Blacksmiths and Iron Workers, the National Brass Workers and Metal Mechanics, and the National Union of Enginemen and Firemen.

Mr. Dawtry, Secretary of the Steam Engine Makers' Society, protested against any alteration to the said agreement of December, 1917, adding that the workers were well satisfied with the smooth working of the agreement so far; but they were prepared to consider proposals for amending the agreement so as to make its terms clearer. He criticised a clause (clause 9) of the new agreement proposed, and said that the effect of this clause would be to abolish the right of trade union officials to enter the shops for discussing with the shop stewards grievances that might crop up. The clause stated that "in the event of a question arising which affects more than one branch of the trade, or more than one department of the works, the negotiations thereon shall be conducted by the management with the shop stewards," and Mr. Dawtry was of opinion that unless the trade union officials were present, some new agreement might be arrived at, affecting not only one section, but the whole trade, leading possibly to a good deal of dissatisfaction.

The delegates present strongly expressed their opposition to any separate agreement being entered into between the Employers' Federation and the Amalgamated Society of Engineers.

The chairman, Sir Allan Smith, secretary of the Employers' Federation, in reply, stated that the suggestions made would receive the Federation's careful consideration. He hoped that before the next meeting, to be held in London on the 17th inst., an understanding would have been arrived at between the delegates present and the Amalgamated Society of Engineers, so that a common agreement could be entered into.

Speaking last Saturday in Sheffield, at a meeting of the Foremen's Mutual Benefit Society, Mr. W. L. Hichens, chairman of Messrs. Cammell Laird and Co., Limited, strongly sympathised with the claim for shorter hours of labour. Better education was another urgent reform. These and other schemes were both desirable and necessary, but they could not be carried out for nothing, and a serious problem was how to find the money to pay for them. Unfortunately, the Government was not encouraging the people to consider that problem. There was also needed a much fairer distribution of wealth between capital and labour than had obtained in the past. He could not help feeling that if a man started life with nothing and ended, say, with millions, he had been greatly overpaid for his services. Better distribution would be a solid gain, but it would not help in the task of paying the very large sums required for carrying out the numerous reforms in social conditions which were meant by reconstruction. The more recent statistics showed that the income of the country divided up only worked out at 3s. per day per head of the population. The problem was how to increase the wealth in order to pay for the coming improvements. Capital was necessary to carry on trade and industry, and was provided out of the savings of the people. More savings and more capital were wanted. Merely distributing the existing wealth more equably would not achieve this end. It could only be done by increasing production. The possibilities of the improvement of the material conditions of living were governed by the extent to which we could increase production. Without this, all the other plans were simply camouflage.

One means of increasing production was by the greater utilisation of mechanical processes. He believed that we were only at the beginning of the development of machinery, and every task that could be shifted from the human being and put on the machine would represent a distinct gain. The machine would do a hundred times as much work, and the human labour set free could be utilised for some other purpose. Unfortunately, there was a tendency to reduce output in this country. In the 'eighties the output per head, both of our population and of that of America, could be represented by the figure 400. To-day it was about 240 in this country, while the American output had gone up to 600. If that tendency continued, the country would soon be finished in an industrial sense. The acquisition of sufficient machinery would necessitate the expenditure of hundreds of millions of money, and it would be profitably spent. To raise the capital the people must be encouraged to save, and they would not do that except by the inducement of some material advantage. The workman must be induced to work more diligently and rapidly by the assurance of a fair share of the extra wealth which he created, and it would be necessary to give the investor reasonable security for a return on the earnings he had invested. These ends could be ensured by arranging for a fair distribution of the products of industry between capital and labour.

The following information, taken from the German press, will be found of interest:—

According to an article in *Die Konjunktur* (December 12), the scientific Commission for settling the preliminaries for the nationalisation of the means of production in Germany has begun its activities, and almost at the same moment the financial agreements of the Armistice Commission were published, which clearly show the fixed resolve of the enemy to keep possession of the national wealth of the country in order to ensure their claims. And at this crisis Germany contemplates nationalising every sort of private property—coal mines, potash fields, chemical works, &c. By so doing she is playing into the enemy's hands, who will thus acquire resources from which any claims made by them can be met. Much may be said for nationalisation *per se*, but in view of the menacing peace terms any increase of the national property should be avoided, for the result is national slavery in alien service. This point certainly is appreciated by the leading circles, but it is not so clear that the labour class grasps it. If the matter was explained to them, workers would realise the dangers of nationalisation in the present circumstances, and the economic policy of the country would be brought back into its proper lines. The prospect is in any case dark, but disaster may yet be avoided. The Nationalisation Commission must defer its activities unless it wishes to hand over the most valuable means of production to the enemy. It is obvious that the enemy would seize all the newly-nationalised property. As it is, they will demand, and receive, guarantees for the fulfilment of the peace conditions. But there is a distinction between supplying new guarantees by nationalisation at the cost of the German economic system and furnishing them from what is already owned by the State. It cannot be doubted that the German labour class, if the case is clearly put before them, will decide in favour of the right course, for they will not wish to exchange "wage-slavery" in the service of private capital for the more burdensome "national slavery" in the service of aliens.

The *Kölnische Zeitung* (December 9) publishes an appeal to German workers, issued by the Union of Employers and Employees' Associations, which may be summarised as follows:—

"The terms of the armistice and over-hasty demobilisation have seriously injured the economic mechanism of the country. Industrial and agricultural districts are confronted by a shortage of labour caused by overcrowding in the larger towns. The mines are undermanned, the coal famine has become intense, and factories are forced to close down. There is a lack of fuel, warm clothing and housing accommodation. There is a shortage of labour in the iron and steel industry. Without agricultural machinery there can be no harvest, and consequently no food. In many places there is a shortage of labour in the transport industry. The Entente have taken away 600 locomotives and 150,000 trucks, and those that remain must be carefully managed. Agriculture and forestry lack men. There is a lack of timber for building, fuel and mine props. The adjustment of the forces of labour is the necessity of the hour. Men out of employment must seek for it in agriculture and forestry. The lack of opportunity for work in the towns will last a long time, since raw materials and auxiliary materials are not being imported and no orders are coming in. The ex-soldiers who have a right to be given their old posts are swarming into the overcrowded factories in the large towns. Never in the history of Germany will united effort be so necessary as in the next few months. All men out of employment should apply at once to the Labour Bureaux and ask advice of the Demobilisation Committees. The railway fares of all who change their place of employment are to be defrayed from public funds."

According to *Welthandel* (December 6), the management of the Thüringian Industrial Union have adopted a resolution calling for the restoration of economic security and stability. They refer to the extraordinary rise in the cost of production that must follow on the satisfaction of the demands now made by workers in all fields of employment. The home demand for all kinds of goods will fall off owing to the rise in prices, while the industries will be unable to compete in foreign markets with countries that do not have to cope with such increases in wages. The result will be extensive unemployment. The suggested control of industry by the workers will only make matters worse, since they lack technical knowledge and commercial experience. A repetition of Russian conditions is to be feared, unless the workers and their Councils recognise the need for moderation and put a stop to their present proceedings. Even Kautsky has admitted that the chief duty before the German people is the restoration of economic life in order to avoid a catastrophe that would strike the workers hardest of all.

The *Deutsche allgemeine Zeitung*, for December 4, in the course of an article on Germany's iron and steel trade, states that the difficulty of obtaining labour is due to the fact that work at the blast furnaces is hard and contains an element of danger, and consequently for decades those concerned have been endeavouring to lighten the labours of the workmen so far as may be technically possible. A large percentage of the accidents in the blast furnace establishments were incurred by the men on the furnace platforms, who feed the furnaces with coke and ore. Their health is affected by the poisonous furnace gas and by the flames from the furnaces, but these dangers might be almost entirely eliminated by the provision of automatic inclined hoists. The difficulties of other branches of the blast-furnace industry might be avoided by the more extended use of specially devised apparatus, such as the pig-casting machine.

To those who have read the German technical press for many years past, and who have thus been able to follow the German claims for improvements in every branch of the German iron and steel trades, coupled with statements as to the backward situation of these trades in other countries, it comes rather as a surprise to read the above paragraph in the *Deutsche allgemeine Zeitung*. This latter, however, it should be noted, is not a technical journal.

ELECTRICITY SUPPLY.—In reference to the following Order made by the Minister of Munitions, namely, The Electricity (Restriction of New Supply) Order, 1918, dated November 8, 1918, the Minister of Munitions has now ordered as follows:—(1) As from the 10th inst., the said Order is revoked. (2) Such revocation shall not affect the previous operation of the said Order or the validity of any action taken thereunder or the liability to any penalty or punishment in respect of any contravention or failure to comply with the said Order prior to such revocation or any proceeding or remedy in respect of such penalty or punishment. (3) The new Order may be cited as The Electricity (Restriction of New Supply) (Revocation) Order, 1919.

PERSONAL.—Thermit, Limited, announce that Mr. Cecil Leigh, F.I.C., for many years chief chemist of the Birmingham Metal and Munitions Company, Limited, has been appointed general manager of the company.—Mr. J. M. Kennedy, O.B.E., M.Inst.C.E., has resigned his position under the Ministry of Munitions as Superintendent of the Government Rolling Mills, Southampton, in order to rejoin his firm, Messrs. Kennedy and Donkin, consulting engineers. Mr. Kennedy was primarily engaged as chief engineer on the construction of the factory mentioned, and its power-house—the work being carried out by direct labour; subsequently, when the factory had been working some months, he was appointed superintendent. On the conclusion of hostilities, the staff and employees, numbering over 2,000, presented Mr. Kennedy with a silver tea service as a mark of the goodwill which existed among all ranks.—Messrs. Drake and Gorham, Limited, inform us that owing to the expiration of the lease of their present offices in Manchester, they will remove, on January 27, to 29, Piccadilly, Manchester. The telephone number of the firm is 3700, and their telegraphic address, "Accumulator, Manchester," will remain unchanged.

SUBSTITUTES FOR BRASS, &C., IN INSTRUMENT-MAKING.—When copper was "mobilised" in Germany in the beginning of 1916, instrument makers had to find a substitute for the brass of which they had been making so large a use. In many cases iron and steel proved quite serviceable, though there was trouble because the iron castings were not always so neat and accurate as the brass castings, there having been less demand for iron castings of high finish. The chief material utilised was, however, zinc, as such and in various alloys. Nickel for electro-plating becoming likewise scarce, cobalt was successfully adopted; in general the alloys were merely varnished. That iron, zinc and aluminium have also become important materials for electrical engineers, has been mentioned on other occasions. Various impregnated cellulose preparations have been introduced as insulating materials under the name of cellon, tenazit, turbonit, wenjazit, &c. Discussing these questions in the "Beiblätter" to the *Zeitschrift für Instrumentenkunde* (September 15, 1918), H. Krüss expresses the opinion that instrument-makers should try to make the best of brass substitutes even in normal times.

DRAUGHTSMEN.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to the letter regarding "Draughtsmen" which appeared in your columns on the 3rd inst., "Vassal's" experiences are, indeed, unfortunate. One of his complaints appears to be that he has been receiving 4*l.* per week for doing practically nuthing.

I do not know what policy the Government follows in regard to wages when other employers are the payers. However, I do know personally of many draughtsmen who have given the best years of their life in the direct service of the State who are in receipt of 3*l.* per week for doing highly important work, and who have received no increase in pay for eight or nine years.

Yours faithfully,

J. G. BEDFORD.

"Jasmine," Grosvenor-avenue, Wallington, Surrey, January 10, 1919.

THE POSITION OF THE OFFICIAL IN ENGINEERING AND OTHER WORKS.

TO THE EDITOR OF ENGINEERING.

SIR,—I was very interested in "Ex Officials" letter which you published in ENGINEERING on December 20 last, and I think the thanks of executive officials in engineering works are due to him for it and to you, Sir, for publishing his letter. We higher staff members have in many works been very unfairly treated during the war, and I have been very greatly impressed by the fact that we are now about the only members of the staff not backed up by an organisation, and I think it is high time something was done to start such an organisation. With this in view I am hoping that you will publish this letter and invite your readers to put forward their views on the matter. I think that the Association of Engineering and Shipbuilding Draughtsmen have much to thank you for in allowing them to ventilate their ideas in your columns, and I have no doubt that you will do a like service for the higher officials in engineering works so that some workable arrangement can be devised.

On one hand we have the employers' federation watching the employers' interests, and on the other we have the trade unions and clerks' and draughtsmen's associations. There is no doubt that the position of draughtsmen has been immensely improved since the association got into working order, while the higher officials, though expected to give—and who have given—unstinted loyalty, have been exploited and, in many cases, where war bonuses have been given, these scarcely suffice to meet the increased income-tax, let alone the extra cost of living.

Yours faithfully,

"AN OFFICIAL."

THE INSTITUTION OF CIVIL ENGINEERS.*

SLIPS AND SUBSIDENCES ON THE CEYLON GOVERNMENT RAILWAYS.

By AUSTIN GEORGE COOPER, M.Inst.C.E.

THE railway system of the Island of Ceylon comprises 605 miles of line of 5-ft. 6-in. gauge and 95 miles of 2-ft. 6-in. gauge, with 112 miles of extensions and branches under construction or being surveyed. This paper describes the damage at certain places on the broad-gauge line from Colombo to Kandy and Bandarawela, and on the branch from Mandy to Matale, which occurred during the north-east monsoon in January 1913, the temporary repairs made, and the permanent work since carried out at those points.

The climate of the island is very wet in the southern and central portions and dry in the north. In the south-west and north-east monsoons heavy and continuous rains for long periods cause damage to the railway by slips and subsidences through the mountain country and heavy floods which result in washaways in the low country. The average annual rainfall ranges from 85 in. in Colombo on the south-west coast to 220 in. at Padupola in the mountain district, while at Jaffna in the north it is 48 in.

SLIPS ON THE MAIN LINE.

Slip at 152 Miles 20 Chains.—The line here descends along the side of a mountain spur, at an elevation of about 5,000 ft. above sea-level and on steep sidelong ground. The subsidence was caused by the land at the foot of the slope becoming waterlogged by the overflow from the streams. When the slip began the formation cracked and sank 10 ft. for a length of 80 ft., the cracks extending out and down to the foot of the slope 250 ft. below the line, the whole of the area enclosed subsiding and breaking up. The temporary measures consisted of sluing the track as far as possible towards the cutting, which is about 70 ft. deep, excavating down to a solid benching and building a sleeper crib to carry the track.

The permanent work consists of stream diversions above and at formation level to take the water permanently away from the subsidence, widening the cutting and deviating the track on to solid formation sufficiently far from the subsidence to ensure safety in the future, building a concrete retaining wall at the foot of the slope below the railway, lining portions of the stream courses above the wall with masonry, and draining the slope above with deep rubble drains, these discharging through the wall and the streams over it.

Slip at 154 Miles 40 Chains.—The line at this place runs along a hillside, the ground being intersected by steep stream courses which, during dry weather, carry no water, but in the rainy season are swollen into small torrents. The area covered by the slip is about 15 acres, and the surface to a considerable depth is composed of sandy clay, thickly set with boulders. Movements in this area have taken place since, and probably before, the construction of the railway. The land had become waterlogged, and in a semi-fluid condition was moving piecemeal down the slope, different parts moving in different years and seasons. The lower strata appear to have become more mobile than the surface strata, and the consequence of this has been subsidences of the surface as the lower strata flowed from under it, portions of the harder surface and boulders lying about irregularly. About 1902, certain protective works, comprising brick drains, a masonry channel and a retaining wall, were built. Between 1902 and 1912 the work was carefully maintained, but the settlement increased slowly until December, 1912, when it began to assume a serious character; and in the following month, as a result of heavy, continuous rain, the damage was extensive. For a short period traffic was maintained by transferring passengers and mails round the slip, but, owing to numerous other slips and washaways occurring shortly afterwards on this section, traffic was completely stopped for a few days.

The temporary measures for restoration of the traffic included the installation of an aerial tramway of a working capacity of 10 tons per hour, to carry goods in case of the line again becoming blocked. It was not, however, necessary to use this tramway. Since the permanent work has been completed no large movement of the slip has occurred.

The permanent works comprise water diversions, cutting back and draining the slip, deviating the track, building retaining walls and other minor work. The main water diversion consists of deflecting walls across the stream courses taken down to a solid foundation and connected by a masonry channel from a point above the top of the slip down to a new 6-ft. arched culvert built under the track, with a masonry outlet stepped down to the natural stream course well clear of the slip. The deflecting walls were built of squared masonry in cement mortar with Portland cement concrete footings. The channels were of squared masonry in cement mortar, the side walls being fine-jointed, but the invert with 2-in. joints filled with fine concrete. For the greater part of the length of the channel the excavation was in hard clay, and no concrete was required under the masonry invert, but where the foundations were not so good this was provided. The slip was cut back clear of the track on the high side to a width of 50 ft. with a slope of 2 horizontal to 1 vertical, and deep rubble drains were laid to ensure good drainage.

The permanent deviation was made to remove the track as far as possible from the toe of the portion of the slip above the line, and to flatten the curves to meet any sharpening which might occur if any further movement took place. The area of the slip has been planted with grass and acacia trees to bind the surface, and to throw off the water.

At the time the estimates were prepared a retaining wall above the track was considered, and trial pits were sunk to prove the foundation. These pits were taken down 35 ft. below rail-level, but the bottom at this depth proving unsuitable, the proposal to build the wall was abandoned, as the cost would have been prohibitive. From the distortion of the timbers which took place in the pits it was evident that the slip had a thickness exceeding the depth of the pits.

SUBSIDENCES ON THE MATALE BRANCH.

This branch descends from Kandy 1,600 ft. to Matale, 1,130 ft. above sea-level, for the greater part along the lower slopes of a range of hills on one side of a valley which is subject to heavy bursts of rain. The railway runs along either steep sidelong ground, or crosses arms of the valley on heavy embankments. The soil is of a very friable nature, and the maintenance of the drainage is expensive. Where streams occur their courses are in many cases a considerable depth below formation level; and in building the railway, the usual practice of diverting them through culverts round the nearest spur, and filling the original stream courses with rubble stone, has been followed. The embankments are, however, liable to become sodden at the foot from percolation of water through the original stream bed, and if in this condition when heavy bursts of rain occur they may become waterlogged and subside. The washaways on this branch now referred to occurred during the heavy rains of January, 1913.

At 11 miles 77 chains the line crosses rice-fields on a high embankment, which became water-logged and partially subsided. A temporary bridge of sleeper-cribs and baulk timber was built to carry the road, and the following permanent work was executed. Brick drains were constructed to replace open earth drains above the embankment, to take the water to the existing culvert. A retaining wall was built at the toe of the embankment on the low side, with drainage through the wall down to the stream course below. The excavation for the wall was in trench, and it was built of Portland cement concrete reinforced with old angle check rails. When refilling the embankment, the sleeper cribs were removed one at a time, working from one end of the bridge by bridging over each crib in turn with suitable shallow girders, which were built locally, the ends of the girders resting on the next crib forward, and on smaller cribs built on the new bank, which had been well rammed. Similar subsidences occurred elsewhere on this branch and were dealt with in the same manner.

The cost of the work in connection with the above-described slips and subsidences, including acquisition of land, amounted to approximately 20,000*l.*, the total cost of the work on the railway in connection with slips, subsidences and washaways due to heavy rains in 1913 being approximately 40,000*l.* The temporary works were carried out by the staff and labour of the Way and Works Department of the railway, and the permanent work was let out to native contractors working under the supervision of the author, who was in charge of the upper district as resident engineer.

* Abstracts of two papers read before the Institution on Tuesday, January 14.

PIETERMARITZBURG-RIET SPRUIT DEVIATION.

By FREDERICK WILLIAM SCOTT, M.E., Assoc.M.Inst.C.E.

THIS deviation is a portion of an extensive scheme of improvement of the Natal Railways main line. The existing main line has proved inadequate to carry the traffic (especially the heavy coastward coal traffic from the Northern Natal coalfields), by reason of the heavy gradients and excessive curvature. The ruling virtual gradient of 1 in 24·4 has been reduced on the section covered by this deviation to a gradient of 1 in 65 against the load, and 1 in 50 against "empties" traffic. The curvature has been reduced 55 per cent., the minimum radius of curvature increased from 300 ft. to 495 ft., and "rise and fall" reduced by 162 ft. at the expense of an increase of length from 16¼ miles to 18¾ miles. Connecting lines, from the main deviation to stations on the existing main line, enable the best portions of the existing main line to be retained, and form an alternative route serving for local and suburban traffic, and as an auxiliary to the deviation in case of congestion.

The earthworks on the main deviation are unusually heavy, averaging more than 90,000 cub. yards per mile. The excavation was through red soil, sandy clay, clay and boulders, and shale formations. Difficult problems were presented by heavy landslips, due to shale beds on the clay, breakdown of the cohesion of the soil, and cleavage in shale cuttings. A slip at 12 miles, described in the paper, caused by a pocket of boulders sliding on a shale layer over sandstone, occasioned the removal of 30,000 cub. yards of extra material.

The moving mass on the largest slip on the line at 5 miles amounted to 400,000 cub. yards, and after the collapse of a retaining wall built to hold it back, the cutting had to be abandoned and the line deviated. Two large slips at 6½ miles and 13½ miles, after a first failure, were dealt with successfully by placing boulder bottoms on the cuttings, packed in ashes, and backed by a wall of old steel sleepers and rails. A special method of treatment, applying to minor slips above formation level, is described, and a heavy slip in a deep shale cutting caused by cleavages.

Three tunnels were originally projected, but an open cutting was substituted for the first (a double-line tunnel), after treacherous material had been disclosed in the heading. The other two tunnels were built, one 311 ft. long on a sharp curve, and the other 2,727 ft. long on the straight. The methods used in the alignment of the latter are briefly outlined. The excavation was carried out by pneumatic drilling, and passed through a variety of materials, chiefly dolorite. Some difficulties were met with while excavating in boulder dolorite and in soft damp marl in a fault. The tunnels were lined with concrete throughout. Concrete was used throughout the works for culverts, bridges, subways, &c. A peculiar foundation failure, caused by release of underground water below a subway, is described. Old-rail reinforcement was freely used; and an example of a culvert, built to act as a girder, is given.

PHYSICAL SOCIETY OF LONDON.

AT the meeting of the Physical Society of London, held on Friday, November 22, 1918, at the Imperial College of Science, Professor C. H. Lees, president, in the chair, a "*Note on the Linguistic Nomenclature of Scientific Writers*" was read by Mr. A. Campbell, B.A. The Note insists on the importance of clear and consistent nomenclature and the avoidance of foreign plural forms, such as *media, genera, radiivectores*, &c. The term "pulsatance" is suggested as a suitable name for $2\pi \times$ frequency.

Discussion.—Mr. A. P. Trotter said that he often thought the valuable work done by Professor S. P. Thompson, Mr. Duddell and Dr. Russell in connection with the nomenclature of electrical engineering might have been taken up in connection with other sciences. The Americans were coining new scientific terms much too fast—in photometry, for instance—and many required careful definition and the restriction of their use to their proper spheres. The work on the Electrical Engineering Nomenclature Committee had been most interesting, and he thought a small committee of the Physical Society could profitably take the matter up.

Dr. A. Russell congratulated Mr. Campbell on raising an interesting question. Personally he was indebted to Mr. Campbell for many words. As regards classical plurals, it was always rather unpleasant to him to hear words like memorandums, radiuses, &c. Lemma had been mentioned by Mr. Campbell; he always regarded this as being an English word as much as Greek, and thought in most cases it should be left to the literary sense of an author which form of plural to use. As regards ω, this he always looked on as the angular velocity of a rotating vector, and had never found it necessary to use a specific word for it.

Professor G. W. O. Howe pointed out that one could not correctly say "an alternating current with an angular velocity ω," since the angular velocity had no reference to the physical alternating current, but only to its graphical representation; one could avoid the difficulty by saying that the current had a frequency $\omega/2\pi$. Some years previously, when he had been on the staff of a firm in Berlin, there was a strong feeling among

a number of German engineers against the introduction of non-Germanic technical words. The word Telephon was replaced by Fernsprecher, and objection was taken to such words as booster, the synthetic German compound word being insisted upon. As an indication of the interest taken in such questions, it may be mentioned that, by a mutual agreement among the members of the staff of one department of the works, anyone who at the luncheon table used a word which was not of pure German origin was fined for the benefit of a common fund.

Professor A. W. Bickerton said that he had found a serious deficiency in words when working out his new cosmic generalisation and had found it convenient to coin several new terms. For instance, he had used the word "kinetol" to represent the kinetic energy of unit mass, and "thermatol," the amount of thermal energy per unit mass, &c.

Mr. C. C. Paterson said that the termination "-ivity" to indicate a specific quality of a material was one that should be more widely employed. He thought the termination "-ance" should always be carefully limited in its application. It was dangerous to limit the meanings of all words too closely, as there are then no words left for general conceptions. The Americans have already used up nearly all the available terms, and earmarked them for particular meanings. Almost the only one not so treated is "light."

Professor Lees said that we appeared to delight in language irregularities. For instance, probably everyone was agreed on the pronunciation of the words "nation, national," but what about the similar pair "ration, rational"?

Mr. T. Smith (communicated remarks) considered that the note called attention to a matter which had been neglected to a most unfortunate extent. He must plead guilty to having regularly used some of the plurals to which the author took exception, the forms used being, so far as he had noticed, those most frequently employed. A liberal-minded committee charged with the duty of admitting and systematising new scientific words and encouraging their use would be of great assistance at the present time, but there would unfortunately be a considerable risk that a committee appointed for this end would contain a strong conservative element, which would perhaps tend to grow stronger as time went on, whose object would be to strangle words struggling for recognition. An illustration of the unfortunate tendency in English to combine two words on one of which a large variety of meanings was thrust, rather than to coin short new words for fundamental ideas, could be drawn from optics. The word "power" was used by itself to denote a definite property of a lens; the same word was also used in "resolving power," there being no connection between the "powers" in the two cases. Again, "magnifying power" was used of telescopes and microscopes with different meanings in the two cases. Many other illustrations could be given, but it was clear that the time had come when an attempt should be made to deal with the matter systematically.

Mr. Campbell, in reply, said he had been much interested in the various comments. He would like to draw Mr. Trotter's attention to the work which a nomenclature committee of this society had already done. Dr. Russell's remarks mainly amounted to saying that having done a thing habitually he did not like to change the habit. But very little practice gets over the repugnance. As regards Mr. Paterson's complaint about over-limitation, there were at present too many loosely used words in scientific terminology. For instance, "pressure" had been stolen from dynamics, and used to mean voltage or potential difference. If chemists were to use the same name for different things in this way there would be frequent cases of poisoning. He agreed with Professor Howe's objection to calling $2\pi\sim$ an angular velocity. He was glad to hear Professor Bickerton's remarks on the need of new terms in astrophysics.

The following three notes were then read by Mr. Campbell:—

"*A Note on Low-Frequency Microphone Hummers.*" The note describes the conditions of mechanical loading, capacitance and position which the author has found give successful working at low frequencies.

"*A Simple Tuning Fork Generator for Sine-Wave Alternating Currents.*" The arrangement consists of an electrically maintained tuning fork, to one prong of which is attached a small thin coil with its axis perpendicular to the direction of motion of the prong. As the fork vibrates the coil oscillates in the field of a fixed horseshoe magnet and an approximately sinusoidal E.M.F. is set up in the coil. The frequency with the apparatus shown was $10\sim$ per second.

"*A Method of Comparing Tuning Forks of Low Frequency and of Determining their Damping Decrements.*" The method consists in putting the windings of the maintaining magnets in series with each other and with a sensitive vibration galvanometer. The beats are clearly shown by the pulsations of the band of light on the scale.

Discussion on Previous Three Notes.—Mr. D. J. Blaikley said that in connection with the harmonics or partial tones there was considerable confusion of terminology. Some writers confine the term "harmonics" to those in arithmetical progression with the fundamental. Partial tones not in this series should simply be called partial tones. For instance, in a tuning fork the first partial tone is not harmonic.

Dr. D. Owen thought the vibration galvanometer method for comparing frequency and measuring decrements was much better than any method using a telephone. Why was the method principally applicable to low-frequency forks? With regard to the tuning-fork generator, he could not see on what grounds Mr. Campbell states that he gets a sine-wave current.

Mr. I. Williams asked if Mr. Campbell had tried an electromagnet with this apparatus. One could then control the shape of the field, and therefore the wave-form of the E.M.F.

Mr. L. Hopwood said he would like to thank Mr. Campbell for the helpful remarks with which the demonstration had been accompanied. If he had had that information early in the war it would have saved him a considerable amount of wasted time.

Professor Lees said he was interested in the point about the influence of the measuring apparatus on the results. He thought the effect would be very small. We know the amount by which damping modifies frequency and the pumping due to the power taken by the galvanometer was very little. In connection with the position of microphones he had once been experimenting with a diaphragm. When tilted so that the concavity due to gravity was upwards, it worked regularly. In other positions it was much less regular.

Mr. Campbell said he was interested in Mr. Blaikley's remarks. He was right as to the nomenclature of partial tones and harmonics. Even Lord Rayleigh, he thought, called the tone at 666 the first harmonic of the 100 fork. So did the French writers. In reply to Dr. Owen, he only mentioned low frequencies because the method was the only one suitable for these frequencies. Higher frequencies could easily be done acoustically. With regard to the wave-form obtained with the generator, if one waves a bit of paper rapidly to and fro' in front of the galvanometer shot it is clear that the E.M.F. is nearly of sine form. This was all he claimed for it at present. With regard to Professor Lees' observations, he quite realised that the effect of the damping on the frequency of the forks would be very slight, but he was rather thinking of the effect of resonance in pulling the two forks more nearly together. The explanation of the behaviour of the telephone diaphragm mentioned by Professor Lees might probably throw light on the behaviour of the hummers. He had never known why the tilt was effective.

Professor Bickerton: Why isn't the horizontal position best, then?

Mr. Campbell: Probably in that case the tighter packing of the granules interferes with the efficient working.

THE FRIED. KRUPP COMPANY.

THE balance-sheet of the huge concern of the Fried. Krupp Company, with its present share capital of 250,000,000 marks, mirrors the utter collapse of Germany herself, the net profits of the year amounting to only 4,927,943 marks, against 40,976,456 marks for the previous year and the record figure of 86,465,611 marks for the year 1914–15. No other German firm is likely to feel the transition from extreme war employment, with its vast increase of buildings and plant, to the present state of affairs to such an extent as Krupp. Still, the balance-sheet has come as a surprise to most; even amongst the initiated. The number of employees has at times been doubled, if not more, during the war, and the specialisation of the production naturally enhances the difficulties of the reconstruction period. The immense extensions during the war, however, have to a great extent been provided for by very substantial visible, and probably also invisible, writings-off, which is a satisfactory circumstance from the shareholders' (in this case the Krupp family) point of view. Thus the writings-off for the year 1914–15 represent about double, and those of the two following years four times the figure for the last peace year. This will appear from the appended table, and the effect of these very substantial writings-off is also demonstrated by the fact that buildings, land, &c., which are termed immovable assets, for the year 1914 were put at 238,000,000 marks, and for the year 1917 at only 6,000,000 marks more. It must be remembered that prior to the war the firm devoted much attention to commercial manufactures, and that the export of high-quality goods played a fairly important part in the business; the former branch was entirely neglected during the war, and the latter for the time being, is a thing of the past. For the present the shortage of raw materials will be very seriously felt, particularly as the large Left-Rhenish blast furnaces at Rheinhausen lie in the occupied districts, and it is exceedingly questionable whether these works can keep up their connection with the Krupp establishments in other parts of Germany.

We subjoin a table showing the profits, writings-off, &c., of the Krupp Company for the last five years.

	1913–14.	1914–15.	1915–16.	1916–17.	1917–18.
	marks.	marks.	marks.	marks.	marks.
Share capital	180,000,000	215,000,000	250,000,000	250,000,000	250,000,000
Borrowed money	51,200,000	49,410,000	47,570,000	abt. 45,000,000	abt. 43,000,000
Brought forward	6,926,334	9,385,347	9,977,678	11,002,121	14,679,754
Working surplus	54,004,571	113,229,821	95,928,938	89,065,406	45,201,809
Prior writings-off	21,108,645	37,980,418	85,143,396	83,425,899	68,590,000
Profit on interest	2,203,668	3,142,062	3,763,233	6,990,585	2,561,512
Various revenues	2,051,550	2,505,930	3,670,963	7,895,606	8,233,667
Aggregate profits	65,266,122	128,263,161	113,360,912	114,893,714	56,996,985
Taxes	9,858,249	10,717,965	28,649,923	30,899,115	17,658,182
Workmen's insurance	5,703,934	5,802,283	6,935,117	8,303,834	10,908,234
Welfare expenditure	8,873,330	15,891,955	18,140,886	23,712,170	23,502,626
Net profits	33,904,224	86,465,611	49,657,308	40,976,456	4,927,943
Dividend	21,600,000	25,800,000	30,000,000	25,000,000	—
Dividend, per cent.	12	12	12	10	—
Legal reserve	1,695,211	4,323,281	2,482,865	2,048,823	3,560,045
Extra reserve	2,000,000	3,000,000	2,000,000	5,000,000	—
War reserve	—	10,000,000	—	—	—
Extra writings-off	—	5,000,000	5,000,000	5,000,000	—
War aid	3,000,000	5,000,000	5,000,000	—	—
Workmen's dwellings	—	5,000,000	—	—	—
Pension, &c.	1,000,000	3,000,000	4,000,000	—	—
Workmen on leave	2,000,000	3,000,000	—	—	—
Christmas gratuities	—	—	—	—	—
Tantièmes	150,000	150,000	150,000	250,000	300,000
Krupp Institution	—	20,000,000	—	—	—
General war aid	—	3,700,000	—	—	—
Carried forward	9,385,347	9,977,676	11,002,121	14,679,754	16,047,652

The table above shows the profits, writings-off, &c., of the Krupp Company for the last five years.

As in 1915–16, a further sum of 20,000,000 marks was written off on war buildings, because the expenditure on such buildings to a considerable extent overlaps the financial year 1918–19. This makes the sum under this head on the debit side amount to 50,000,000 marks; in addition 40,000,000 marks have been set aside for war reserve and war damage. Thus the visible prior writings-off amount to about 148,500,000 marks, against 83,500,000 marks for the previous year. As the "immovable" assets, land, buildings, &c., only figure for 334,740,000 marks, against 327,280,000 marks for the previous year, a considerable amount of the heavy outlay for extensions has, in all probability, been provided for, without this being apparent in the balance-sheet. After deducting the ordinary writings-off, the "immovable" assets stand booked at 243,850,000 marks. Stores, finished and half-finished products, show a material increase, figuring for 750,260,000 marks, against 584,230,000 marks for the previous year. This large sum in all likelihood refers to army contracts which, when completed, should be paid for by the military authorities, but the figure in question tends to show the somewhat strained conditions under which the company is at present placed. Several of the items on the liability side of the balance-sheet, such as instalments, amounting to 446,830,000 marks, against 330,680,000 marks for the previous year, and other creditors for 403,730,000 marks (including liabilities for deliveries made to the company 175,660,000 marks, and 184,760,000 marks for wages, freights, duty, &c.) against 369,050,000 marks for the previous year, seem somewhat out of proportion to the company's own resources. Compared with the above large sums a new item on the liability side, an indebtedness to banks of 33,850,000 marks, does not count very much, although it points to the fact, that the company is not well off as regards liquid capital at present, its bank credit only amounting to 12,170,000 marks, against 29,940,000 marks for the previous year. The aggregate amount of "debtors" has risen from 208,050,000 marks to 296,330,000 marks, but contrary to what has been the case with most of the large German industrial concerns for their last financial year, the Krupp holdings, both of stock yielding a fixed interest and of shares, &c., have receded as compared with those of a year ago, viz., from 135,390,000 marks to 112,410,000 marks and from 21,980,000 marks to 15,710,000 marks. Patents and royalties have been entirely written-off. With a share capital of 250,000,000 marks and borrowed money 43,640,000 marks, the legal reserve now amounts to 25,000,000 marks, the war tax reserve to 27,970,000 marks, the extra reserves to 30,000,000 marks, the renewal reserve to 20,000,000 marks, the war buildings reserve, as already mentioned, to 58,000,000 marks, and the Delcredere and guarantee fund to 16,450,000 marks. Amongst what may be called the social welfare funds the fund for welfare purposes proper represents 30,590,000 marks, the credits of the employees 23,480,000 marks, with the firm, and 21,420,000 marks with the Savings Bank institution. About 40,000 employees had gone to the front (the balance-sheet refers to the state of affairs on June 30, 1918), against 32,000 a year previously.

THE GERMAN STATE RAILWAYS.—One of the most astounding signs of the times is the altered financial aspect of the German State Railways. The Prussian State Railways yielded a surplus of 325,000,000 marks in the year 1913; for the year 1917 the surplus receded to 18,000,000 marks; for the current financial year a deficit of 1,325,000,000 marks is reckoned upon, and for 1919 the deficit is expected to reach some 3,000,000,000 marks, and this upon a figure of cost for the railways stated before the war to be some 7,000,000,000 marks. For the year 1918 the average wage under the railways amounted to about 1,280 marks per individual; for 1919 it is calculated at 4,220 marks, an increase of 230 per cent. An increase in the tariffs of 100 per cent. is looked upon as necessary.

THE ENGLISH CHANNEL TRAIN FERRY STEAMERS.

WE begin the publication on the two-page plate accompanying this issue of a complete series of illustrations of the train ferry instituted between Southampton and the Channel ports, by the British Government, in connection with war operations. For the present we propose only to refer briefly to the ferry steamers, of which we give three perspective views. Fig. 1 shows the starboard side of the ship; Fig. 2 the port side, with the stern; while Fig. 3 is a view along the main or train deck. Two of the vessels were built by Messrs. Sir W. G. Armstrong, Whitworth and Co., Limited, at their Elswick Shipyard, and the machinery for these was constructed and fitted on board by the Wallsend Slipway and Engineering Company, Limited, Wallsend-on-Tyne. The third steamer was built and engined by the Fairfield Shipbuilding and Engineering Company, Limited, Govan, Glasgow.

The vessels, which have an overall length of 363 ft. 6 in., and a length moulded of 350 ft., extreme breadth of 61 ft. 6 in. over fenders, breadth moulded 58 ft. 6 in., with a depth of 17 ft. to car or upper deck, are designed to carry 34 railway wagons and two locomotives on four lines of rails arranged on the deck, converging into two lines at the stern, with all the necessary switches and points to enable wagons to be run off, or on, the deck. The machinery, consisting of two sets of inverted direct-acting triple expansion engines, with four cylindrical boilers with oil-burning arrangements, enables the vessels to attain a speed of 16 knots on a limited draught of 9 ft. 6 in.

The vessels are divided into 10 watertight compartments, the two compartments amidships being utilised for the machinery, and the fore and after peaks arranged for carrying water ballast for trimming purposes. The construction of hull is on the transverse frame principle, with web frames widely spaced. A system of longitudinal girders with widely spaced channel pillars are fitted under the car deck for supporting railway trains. These girders have been braced with angle bars, both longitudinally and transversely, from upper deck to floors and girders at bottom. A forecastle is fitted forward on the upper deck, extending aft in the form of side superstructures to protect carriages.

Four powerful capstans are situated on the car deck for moving the wagons and mooring the vessel, and a steering gear is arranged under the deck at the stern for working the twin rudders.

Ample accommodation is provided in rooms under the car deck for officers, engineers, firemen and seamen, and the captain's room and wireless cabin is fitted in a steel house amidships on top of the superstructure over the cars. Galleys, pantries, stores and lavatories are fitted in a superstructure between the cars and the ship's side. The vessels were built of steel throughout and classed with Lloyd's Special Survey for Channel service.

In our next issue we hope to publish the drawings of the vessels, while later drawings will be published illustrating the ingenious arrangement for the running of the trains to and from the deck of the ferry steamer.

THE GERMAN STEEL UNION.

THE last meeting of the Steel Union (December 19) was awaited with considerable interest, and a substantial rise in prices was looked upon as unavoidable, but scarcely anyone anticipated such an unprecedented increase as that of about 50 per cent., or even more, on most commodities. The quotation for shaped iron was put up 100 marks per ton, from 220 marks to 320 marks; that for half-finished products 97·50 marks per ton. The present quotations are as follow: Ingots, 285 marks per ton, formerly 187·50 marks; billets, 290 marks per ton, formerly 192·50 marks; bundles, 300 marks per ton, formerly 202·50 marks; and plates, 305 marks per ton, formerly 207·50 marks—all Thomas quality. Siemens-Martin quality carries a further addition to the quotation of 40 marks per ton. These prices hold good for the months of January and February. It was further decided that the Lorraine and Luxemburg works belonging to the Union, on account of the exceptional conditions, should be at liberty to sell independently.

It was pointed out at the meeting, that the difficulties arising from the occupation by the Entente troops of the districts on the left side of the Rhine, continued to increase. Mention was also made of the consequences which would follow the higher wages, the eight-hours day, and the reduction of output. These factors, it was stated, would lead to the complete collapse even of the best situated works, if a material rise in prices was not adopted. Also, it was pointed out, that the effects of the chronic shortage of raw materials, more especially ore and coal, tended to raise the cost of production through a reduction of the output. Added to this was the low exchange value of the mark, in relation to the franc.

Before the war the price for shaped iron was 110 marks, for ingots 82·50 marks, for billets 87·50 marks, for bundles 95 marks, and for plates 97·50 marks per ton. It will thus be seen that the latest rises in some cases exceed the actual peace-time quotation, and that they are about equal to the aggregate of all the increases in quotations during the war time. It should also be noted in this connection, that the war quotations have not been raised for a considerable period. The works have repeatedly applied to the authorities for permission to raise their prices, but these applications have all been refused, the Government pointing to the ample earnings of the works.

The works particularly affected by the military occupation are the Rombach concern, the Hagendingen branch of the Thyssen works, the Differdingen and Rümelingen works of the German-Luxemburg Mining Company, the Kneutlingen branch of the Lorraine Ironworks and Mining Company, the Esch branch of the Gelsen-Kirchen Company, and the Burbach concern. It goes without saying that this severance of the above-mentioned large and important concerns seriously affects the working of the Steel Union, as the Luxemburg-Lorraine works have large allotments in all sections of the Union. These works may, in fact, be looked upon as main sources of supply as regards shaped iron and half-finished products. This curtailment of the supply will, no doubt, soon make itself very tangibly felt in the distribution of products from the Union, the more so as the remaining works will be materially hampered if the import of foreign ores cannot soon be resumed. The Saar district is placed under similar awkward conditions.

The Upper Silesian works have already for some considerable time shown a pronounced desire to break away from the Union. Their demands will most probably prove unacceptable when a prolongation of the Union has to be discussed, and they will more likely than not prefer to rely upon their local organisations. It was not without much trouble that the temporary prolongation of the Steel Union till June 30, 1919, was brought about; and a further prolongation, on a necessarily much reduced scale, may even cause more trouble. Possibly the days of the Union are numbered.

Further, other combines within the iron industry have decided upon a very substantial rise in quotations. Thus the Wire Convention has raised the base prices an average of 130 marks to 200 marks per ton. The new base prices are: for drawn wire, 450 marks (formerly 320 marks per ton); for galvanised wire, 580 marks (formerly 397·50 marks) per ton; for wire nails, 520 marks (formerly 370 marks) per ton. The plate-rolling mills have decided to raise their prices 180 marks for heavy and 150 marks for thin plates per ton, to take effect from January 1. Also the bar iron export Union is about to raise its quotations.

The Steel Union, in its report for the financial year 1917–18, states that during the past twelve months the demand for munitions and means of defence had been greater than ever. At the same time the export trade was severely hampered and had receded to 5 per cent. of the total sale, against 6 per cent. for the previous year, and 16 per cent. for the preceding year but one. For half-finished products the demand had been so great that even pressing orders could not always be executed. The export had, therefore, been altogether insignificant.

As regards railway material, the rail rolling mills had been very fully employed, more especially as regards heavy rails for the State railways and the military authorities. As for lighter rails, the military authorities and the mining industry were the chief customers. Tram rails were only supplied in limited quantities. A number of contracts were entered upon with neutral countries, mostly for delivery after the war.

The demand for shaped iron had throughout the year exceeded the capacity of the works, especially for wagon and railway construction, for direct and indirect war requirements, and for installations in the interest of the empire. Only very limited quantities became available for the trade and other private customers. Comprehensive orders at exceedingly good prices were received from neutral countries, but it was impossible to execute them to the desired extent.

The export of bar iron, which is controlled by the Union, had, from the same reason, to be greatly curtailed. For the inland trade a Union for the duration of the war had likewise been formed in connection with the Steel Union. The works themselves effected the sales, but the Steel Union controlled the sales and the deliveries for military requirements.

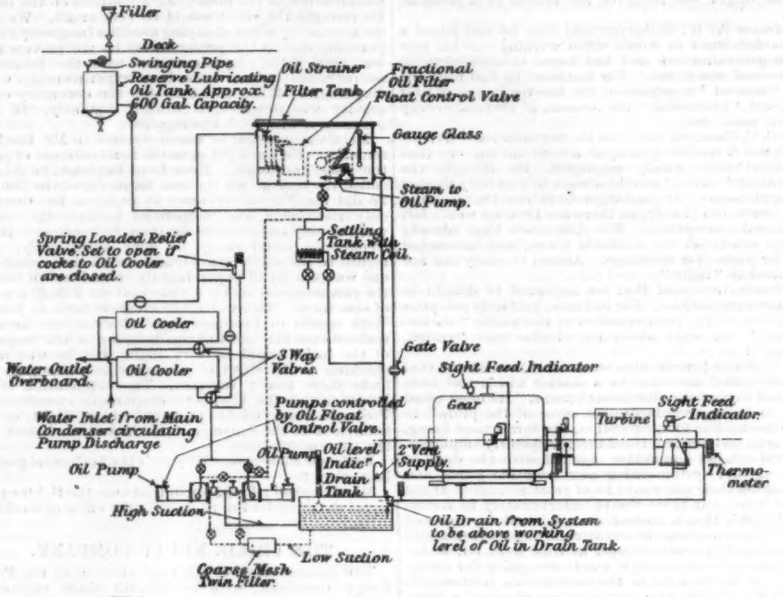
The report also referred to the efforts made to unite all rolling-mill products in a general combine, the German Steel Combine (*Deutscher Stahlbund*), but it was considered expedient to await further developments. It is, however, generally admitted that it is necessary not only to maintain the special unions, but also to arrange for a broader and more comprehensive combine. The liabilities during the year rose from 49,820,000 marks to 127,710,000 marks, and outstanding accounts from 45,600,000 marks to 88,310,000 marks. Trading expenses charged against the members amounted to 2,560,000 marks, against 2,160,000 marks for the previous year.

ELECTRICITY SUPPLY ORDER.—The Minister of Munitions has revoked the Electricity (Restriction of New Supply) Order, 1916, under which no person might, without a permit, supply, connect or use any electricity in any building not so connected at the date of the Order. This revocation, however, will not affect the previous operation of the said Order or the validity of any action taken thereunder or the liability to any penalty or punishment in respect of any contravention or failure to comply with the said Order prior to such revocation or any proceeding or remedy in respect of such penalty or punishment.

PROGRESS IN TURBINE SHIP PROPULSION.

(*For Description, see opposite Page.*)

Fig. 10. **IDEAL OILING SYSTEM.**



PROGRESS IN TURBINE SHIP PROPULSION.

Fig. 11. H.P. ELEMENT OF CROSS-COMPOUND TURBINE.

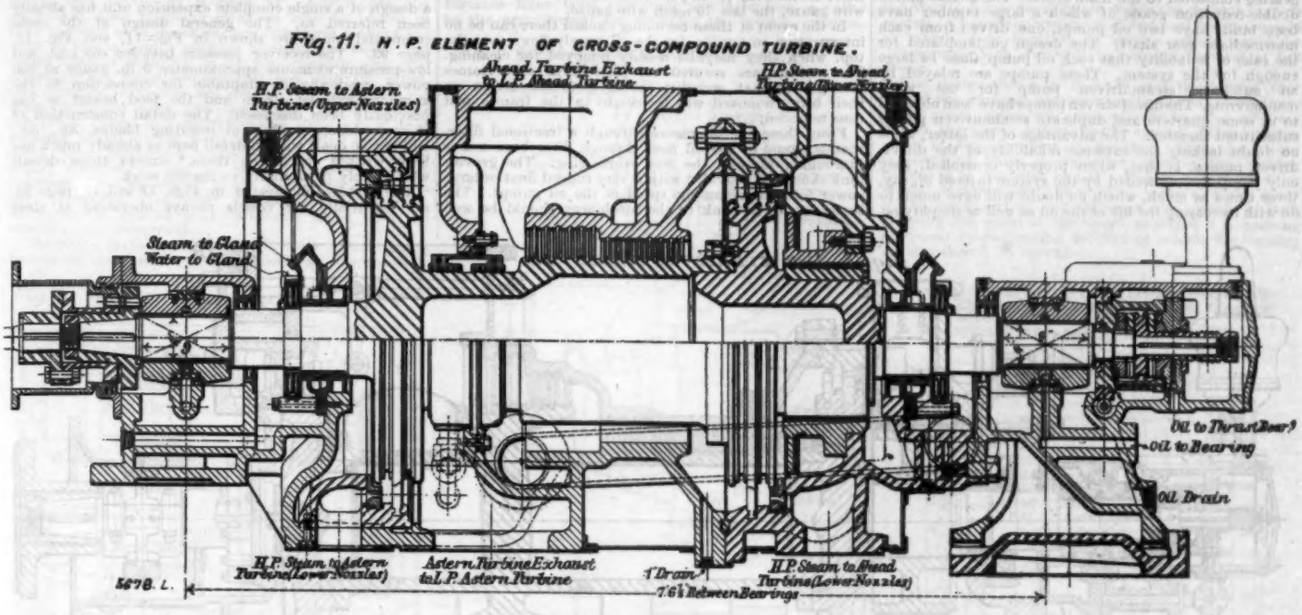
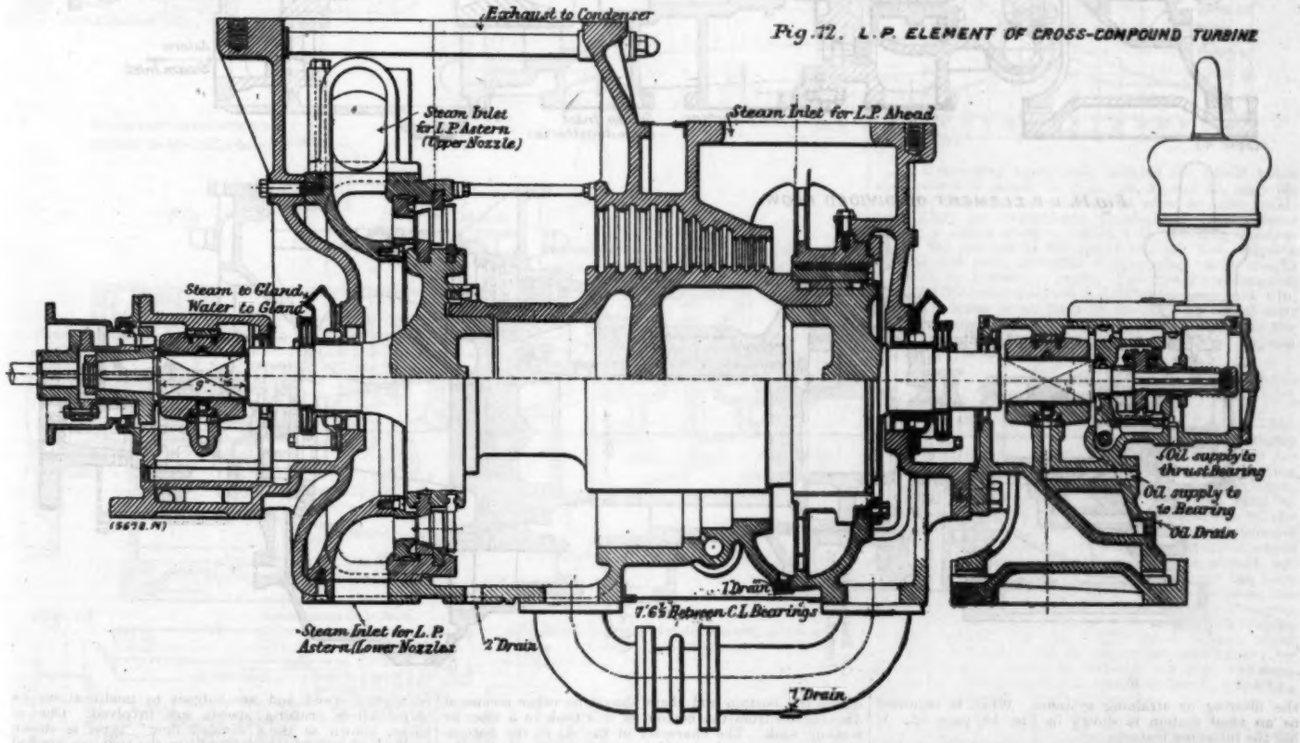

Ahead Turbine Exhaust to L.P. Ahead Turbine
H.P. Steam to Astern Turbine (Upper Nozzles)
H.P. Steam to Ahead Turbine (Upper Nozzles)
Steam to Gland
Water to Gland
Oil to Thrust Bearing
Oil to Bearing
Oil Drain
H.P. Steam to Astern Turbine (Lower Nozzles)
Astern Turbine Exhaust to L.P. Astern Turbine
1 Drain
H.P. Steam to Ahead Turbine (Lower Nozzles)
5678. L.
7 6½ Between Bearings

Fig. 12. L.P. ELEMENT OF CROSS-COMPOUND TURBINE.



PROGRESS IN TURBINE SHIP PROPULSION.*

By Mr. FRANCIS HODGKINSON.

(*Continued from page* 45.)

Condensers.—Inasmuch as turbines may be designed to expand the steam to vacuum of 29 in., and as the steam consumption with such a turbine will be 7 per cent. better with 29 in. vacuum than with 28 in., providing it be designed to expand to such low pressures, the necessity of providing sufficient well-disposed surface to produce such a vacuum is not only obvious, but it is furthermore necessary to have a complete understanding of what constitutes good condenser performance with the apparatus available.

An important detail is the drop in steam pressure through the condenser. For good practice this should not exceed $\frac{1}{10}$ in. mercury. The air pump should be of a type capable of completely evacuating the non-condensible vapour from the condenser so that the condenser shell shall contain nothing but steam, and therefore be of the same temperature throughout except for the small pressure drop within the shell itself. To produce this condition requires not only excellent air removing apparatus, but constant vigilance in the elimination of air leaks. It is the practice of certain large central stations to provide an air bell, which may on occasion be connected to the discharge of air pumps, by means of which the air leakage may be measured. With 40,000 h.p. units, 3½ cub. ft. per minute of free air is considered good practice, and should this reach to 7 cub. ft. it is the signal for a search to discover the source of the leak. Such a practice would be impracticable on shipboard and only serves to point out how central station engineers regard the ill-effects of air leaks.

With such a condenser having practically uniform steam temperature throughout the shell, there is the greatest temperature difference between circulating water and steam in the bottom pass (assuming steam enters at the top and water at the bottom); while on the other hand, in the top pass there is but a small temperature difference. Hence much more steam is condensed at the bottom than at the top, contrary to what is usually experienced with condensers that do not have the non-condensible vapours completely evacuated. This calls for especial care in having paths for the passage of steam through the upper zones of the condenser to insure the minimum pressure drop.

With the complete evacuation of the non-condensible vapours, the vacuum should correspond to a temperature not to exceed 1 deg. or 2 deg. higher than the temperature of the condensed steam leaving the condenser, which is a point that should be kept constantly under observation.

Oiling Systems.—While the oiling system can bear no relation to the economics of turbine-propelled ships, it is of vital concern to the reliability of operation, and too much care cannot be given to the lay-out of the system to the end of obtaining the extreme degree of simplicity and reliability.

* Report, slightly abbreviated, read before the Society of Naval Architects and Marine Engineers, at Philadelphia, on November 14, 1918.

It has been generally the custom in Westinghouse installations to provide oil pumps directly driven by gearing connected to the main gears. The double-pinion double-reduction gears, of which a large number have been built, have two oil pumps, one driven from each intermediate gear shaft. The design contemplated for the sake of reliability that each oil pump alone be large enough for the system. These pumps are relayed by an auxiliary steam-driven pump for use when manœuvring. The direct-driven pumps have been objected to in some quarters and duplicate steam-driven pumps substituted therefor. The advantage of the latter, while no doubt lacking the extreme reliability of the direct-driven pumps, is that, when properly controlled, they only pump the oil needed by the system instead of, say, three times as much, which no doubt will have much to do with increasing the life of the oil as well as simplifying

7. An overhead gravity tank is provided with three strainers having successively finer mesh, the first being sheet metal with $\frac{1}{16}$ in. perforations, the second 30-mesh wire gauze, the last 70-mesh wire gauze.

In the event of these becoming choked there can be no interruption to service, for the oil merely flows over the top, when they may be readily removed for cleaning. The screens are secured to quite large cast frames arranged so that any dirt falling from the screen on their being removed will be caught in the frames and thus removed.

From these the oil passes through a fractional filter, that is, some of the oil runs through filter bags and is thoroughly filtered, the rest overflowing. The gravity tank should be provided with a very rugged float of large power for controlling the speed of the oil pumps. The outlet from the tank to the machinery should be well above the bottom and there should be other means of drawing oil from the bottom of this tank to a filter or settling tank. The character of the oil in the bottom of this gravity tank should be regularly observed to be sure that the water is not entering the system from any source.

8. The system which provides a settling tank, capable of taking a complete charge of oil for the system is to be recommended.

9. It is considered desirable that the oil coolers should be arranged, if possible, to have the oil pressure superior to the water pressure, so that a loss of oil will occur rather than the admixture of salt water. The former would be shown by the oil level indicator which is situated in the lower tank.

There are installations, such as destroyers, where there is but little head room and where a gravity oiling system is impracticable, and a pressure oiling system must be employed. In this case twin strainers or their equivalent must be resorted to. These are, of course, dangerous because of them becoming choked and interrupting the service, or bursting and letting dirt through if the pumps are sufficiently powerful. If they must be employed they should invariably be by-passed through a spring-loaded check valve, loaded to, say, $\frac{1}{4}$ lb., so that with a slight increase of resistance of the strainers, the oil will by-pass them and the service never be interrupted.

Concerning arrangements of the turbines themselves, a design of a single complete expansion unit has already been referred to. The general design of the cross compound units are shown in Fig. 11, and Fig. 12, page 93. The receiver pressure between the high and low-pressure elements approximates 5 lb. gauge at full power, rendering it adaptable for connection to the auxiliary exhaust steam and the feed heater as has previously been discussed. The detail construction of these turbines, method of inserting blades, &c., &c., will not be dealt with in detail here as already much has been written concerning them,* except those details which apply particularly to marine work.

The turbines illustrated in Figs. 11 and 12, page 93, are essentially for vessels always operating at their

Fig. 13. H.P. ELEMENT OF DIVIDED FLOW.

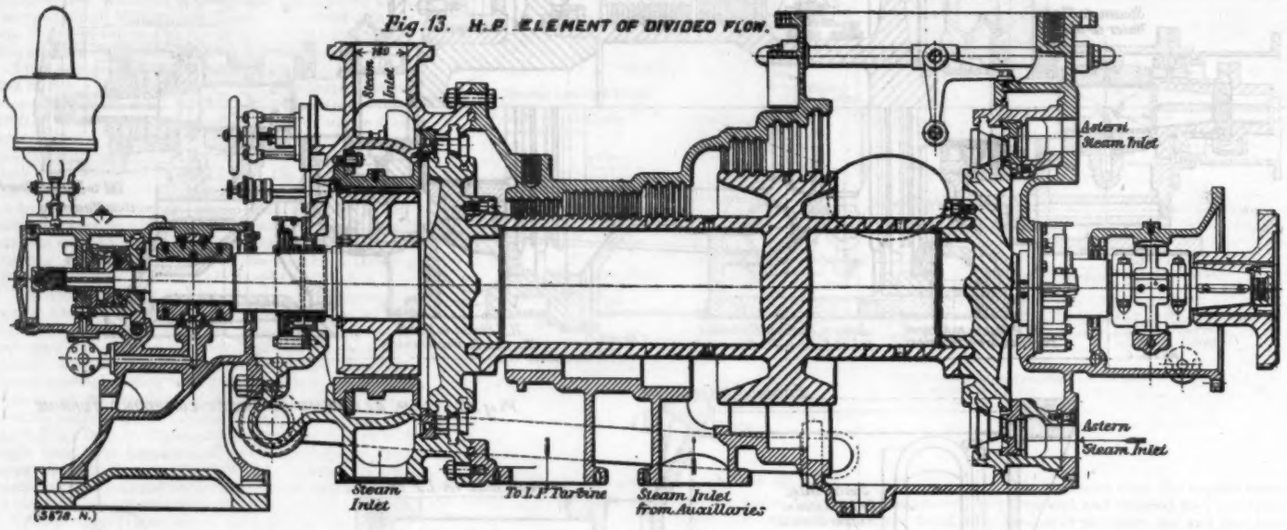
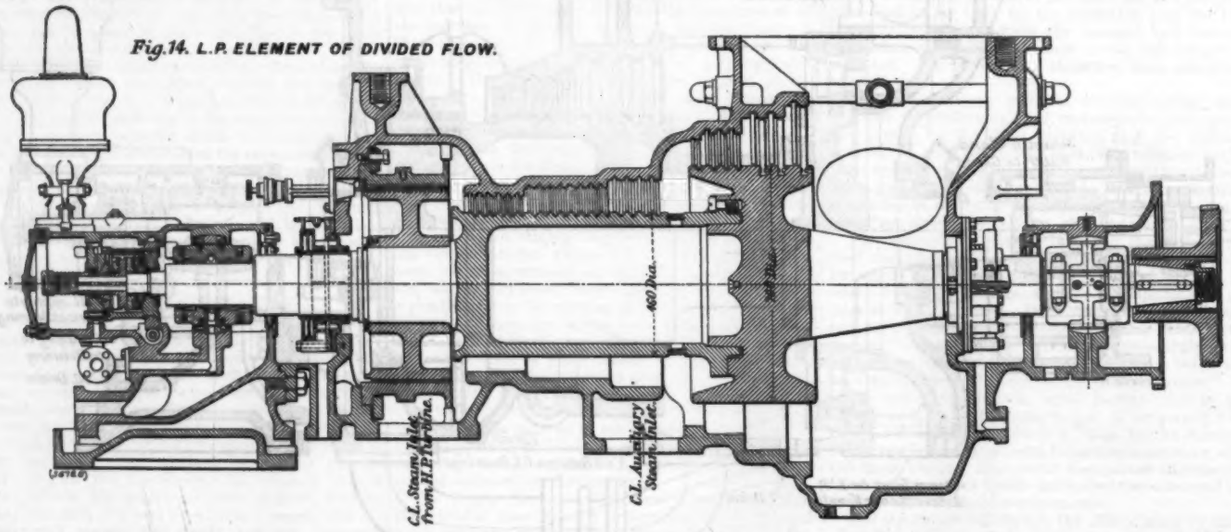


Fig. 14. L.P. ELEMENT OF DIVIDED FLOW.



the filtering or straining systems. What is regarded as an ideal system is shown in Fig. 10, page 92. It has the following features :—

1. The pumps are located at as low a level as possible to reduce the suction head to the extreme limit.

2. The drain tank is of as large a dimension as practicable, and is located sufficiently low to insure the oil draining freely to it from the machinery with ample-sized pipes, and assurance that with the extreme rolling and pitching there will be no leakage from the bearings.

3. The pump suction should be several inches above the bottom of the tank to avoid drawing dirt and emulsion from the bottom.

4. It is regarded as desirable to employ an additional suction from the bottom of the tank by means of which dirty oil may be pumped through a filter and to permit complete emptying of the tank for cleaning purposes.

5. The pump is arranged to discharge its oil through coolers to an overhead gravity tank located some 20 ft. above the machinery.

6. Duplicate coolers are employed so that while one set is in use the other may be cut out of service. They should be by-passed with a spring-loaded check valve, loaded to some amount greater than the resistance of the cooler, so that under no conditions can mishandling of the valves cause interruption to service.

maximum speed and are subject to modifications on ships where cruising speeds are involved. One of these, known as the "divided flow" type, is shown in Figs. 13 and 14, above, and are the turbines applied to a Swedish cruiser. The combination comprises an impulse element in the high-pressure turbine through which passes all the steam to the system. The nozzles are arranged in groups, each under valve control so that the turbine may realise substantially full pressure at the nozzles with widely differing volumes of steam flow. The general arrangement of this combination is shown in Fig. 15, page 93. After passing the impulse element the steam divides, one portion continuing through the same turbine to condenser pressure; and a slightly greater portion passing over to the low-pressure element through which it expands to the condenser. For cruising the one low-pressure element may be cut out of service, the steam closed to certain nozzles, and the turbine operated with fair economy at the reduced power. The reason for a greater proportion of steam passing to the low pressure is in order that the work may be equal on the two pinions at full power.

* See *Electric Journal* for January, February, March, April, 1918.

This divided flow combination is adaptable to constant-speed steamers and will generally give nearly as good performance in steam consumption as the cross-compound unit previously referred to; and it has one advantage, that reversing elements may be placed in both turbines as in the cross-compound unit without the need of the labyrinth packing between the ahead and astern exhaust chambers in the high-pressure elements. Although not being compounded one with the other, the reversing elements are not as economical as the cross-compound unit first described. At full power the steam passes in parallel through three sets of low-pressure blades (if the low-pressure turbine be double flow), thus permitting smaller turbine diameters or higher rotative speeds, or both if desired, without reducing the adaptability of the turbine to expand to low pressures. This type of installation has the advantage of smaller cross-connecting pipes than the straight cross-compound.

There is a further modification of these arrangements known as the "series divided flow" as illustrated in Fig. 16, above, which provides for certain of the turbine elements being operated in parallel for maximum powers and in series for reduced powers. It will be observed from the figure that the blade proportions work out with approximate corrections for either the series or the parallel condition of operation. This combination renders unnecessary the installation of a separate turbine for use when cruising. The relative performance of these respective types of turbines are exhibited in curves Fig. 17, annexed.

Some installations have been made where cruising turbines have been employed and attention is called to the arrangement for coupling the cruising turbine, shown in Fig. 18, above. It has been regarded in the past as desirable that the cruising turbines be arranged so that they may be operated when connected to the main turbines at the maximum speed of the main units, the idea having been that should the engineer go up to full power of the vessel and forget to disconnect this cruising turbine, no injury would result therefrom. This meant that when the cruising turbine was in service it had to operate at very low blade speeds and be therefore quite heavy or the cruising turbine cannot be arranged to be very economical. It is the practice of the Westinghouse Company to design the cruising turbine geared to the main turbine and designed for the speeds at which it is required in service which would be dangerously high should it be not disconnected at full power.

The design shown in Figs. 18 and 19 provides [that should the cruising turbine operate above a predetermined speed, steam will automatically be shut off from it and the clutch automatically opened. The arrangement of this installation provides that the steam manœuvring valve is employed whether the cruising turbine is in operation or not. Means are provided for readily synchronising the cruising turbine to the speed of the main turbine and throwing the clutch without affecting the speed of the vessel, provided it is running at speeds corresponding to that at which the cruising turbine should be operated.

Fig. 15. GENERAL ARRANGEMENT OF PIPING FOR DIVIDED FLOW.

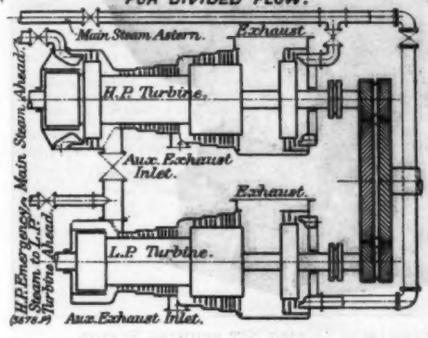
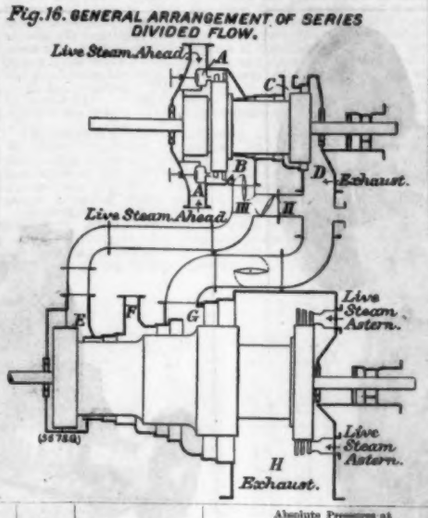


Fig. 16. GENERAL ARRANGEMENT OF SERIES DIVIDED FLOW.



Ship Knots.	Approx. Speed of.	Turbine Speed: H.P.	Turbine Speed: L.P.	Position of Valves. I.	II.	III.	Absolute Pressures at: A	B	C	F	K	D	E	G	H
							H.P. Inlet.	Reaction Blading.	Aux. Steam Inlet.			H.P. Exhaust.	H.P. Inlet.	Last Stage L.P.	Exhaust.
21		3000	2500	open	closed	open	250	80	16·5	21·5	7·1	7·1	80·0	7·1	·741
19		3180	2208	,,	,,	,,	,,	55	11·3	15·0	4·9	4·9	55·0	4·9	·575
15		2440	1695	closed	open	closed	,,	116	34·0	8·7	35·0	35·0	35·0	2·3	·540
10		1665	1156	,,	,,	,,	,,	40	13·0	3·0	11·8	11·8	11·8	·8	·37

Fig. 17. COMPARISON OF ESTIMATED PERFORMANCE CURVES OF WESTINGHOUSE MARINE TURBINES WITH REDUCTION GEARS.

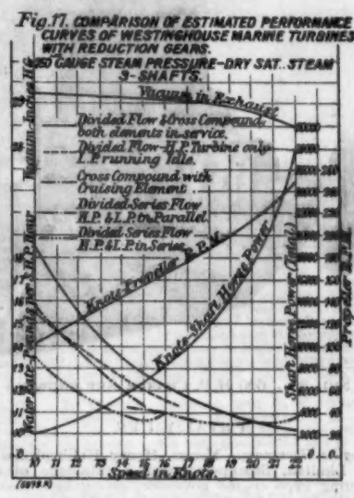

250 GAUGE STEAM PRESSURE—DRY SAT. STEAM
3-SHAFTS.
Vacuum in Exhaust.
Divided Flow Cross Compounds both elements in service.
Divided Flow—H.P. Turbine only L.P. running Idle.
Cross Compound with Cruising Element
Divided-Series Flow H.P. & L.P. in Parallel.
Divided-Series Flow H.P. & L.P. in Series.
Knots Frontier Head Point
Knots Sheet Head Point
Speed in Knots.
(5678 K)

Fig. 18.

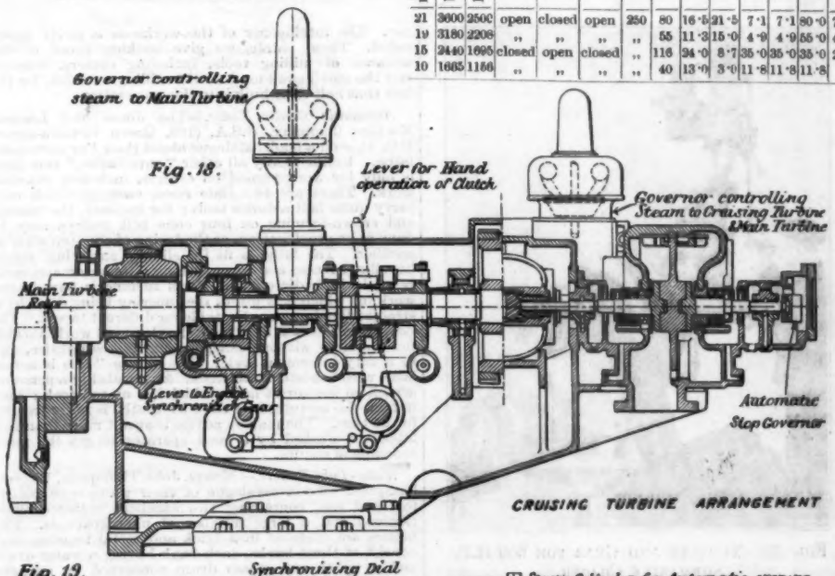
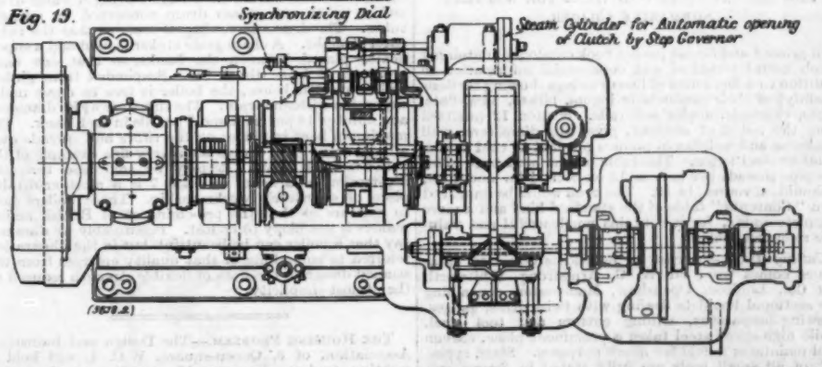

Governor controlling steam to Main Turbine
Lever for Hand operation of Clutch
Governor controlling Steam to Cruising Turbine & Main Turbine
Main Turbine Rotor
Lever to Engage Synchronized Gear
Automatic Stop Governor
CRUISING TURBINE ARRANGEMENT

Fig. 19.



An interesting equipment suitable for patrol boats and cutters is shown in Figs. 20, 21 and 22, page 96, of which three are in service and some 50 more building. They are exceedingly simple, the turbine comprising a single re-entry wheel with reversing buckets cut in the shrouds of the ahead blades. The complete turbine and gear, including manœuvring valve, weighs 4,100 lb. for a 600-h.p. outfit. The steam consumption with 330 lb. steam pressure and 27 in. vacuum is 14·9 lb. per shaft horse-power hour at 600 h.p. by actual test. The reversing element is effective. On actual trial the boat was brought stationary in the water in its own length from full speed ahead.

(To be continued.)

IMPREGNATED BLOCKS FOR WOOD PAVING.—Experimenting on methods of increasing the durability of blocks for wood paving, W. Ritter (*Zeitschrift für Angewandte Chemie*, 1918, page 518) tried impregnation with pine wood tar and heavy coal tars, and with sodium, carbon, &c., and sodium silicate. Of these salts he found each alone to be preferable to mixtures of the two, but the salt percentage used in the tar seemed to be of less importance than the temperature to which the bath was heated. This temperature should not exceed 200 deg. C., lest the blocks split, and the bath should gradually be heated up to that temperature, the whole impregnation taking about 3 hours. The strengths were determined by crushing tests made with blocks, 75 mm. square, 120 mm. high. An untreated block showed a strength of 323 kg. per square centimetre; by impregnating the blocks at 100 deg., 120 deg., 140 deg., 200 deg. C. the strength was raised to 330 kg., 345 kg., 487 kg., 536 kg. per square centimetre.

COLD STORAGE PLANT, &C., FOR ITALY.—By Decree 1747 of November 21, 1918, published in the *Gazetta Officiale* of December 2 provision is made for granting concessions for erecting cold storage warehouses in 10 towns in Italy (Alessandria, Leghorn, Naples, Bari, Rome, Rimini, Palermo, Catania, Golfo Aranci, and Trieste). The work relating thereto is declared to be of public utility. These installations are exempted from the payment of land and income tax for a period of 10 years from the date of opening. Firms which intend to undertake the erection of the plants and to carry on the business have to send in their estimates with plans and particulars, not later than by the 31st inst., to the Commission, which will be appointed at the Ministry of Food. These estimates will be examined by the Commission and be referred by them within 15 days of receipt of the prescribed deposit to the Ministry with recommendations. The Ministry chooses the approved proposals, accepts the applications, determines the period for the completion of the plant, arranges for the payment of guarantee, and declares the work of public utility. The text of this Decree can be consulted at the British Board of Trade Enquiry Office of the Department of Overseas Trade (Development and Intelligence).

PROGRESS IN TURBINE SHIP PROPULSION.

(*For Description, see Page* 93.)

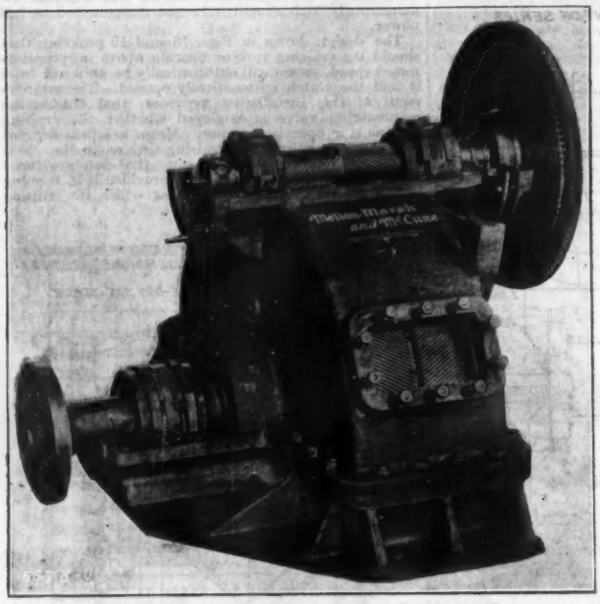


FIG. 20. 600 H.P. CHASER SET SHOWING ROTATING ELEMENT.

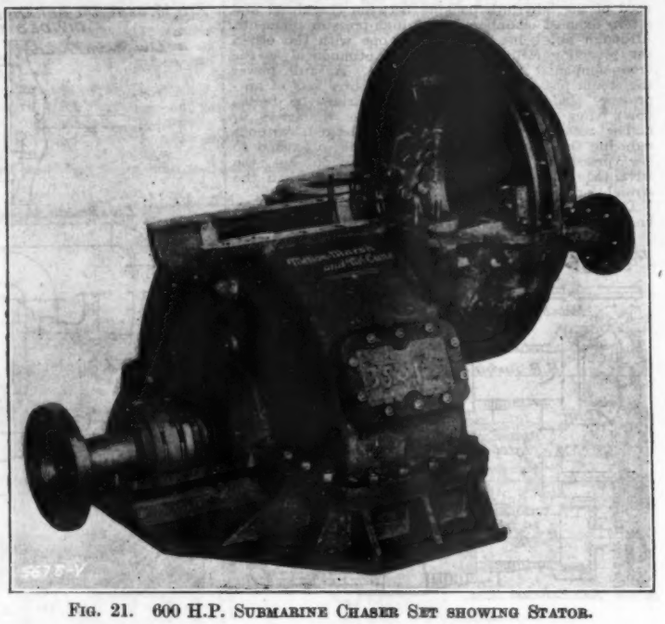


FIG. 21. 600 H.P. SUBMARINE CHASER SET SHOWING STATOR.

CATALOGUES.

Engine Governors.—Messrs. Henry Hollingdrake and Son, Limited, Stockport, send a catalogue of their Pickering type engine governor, giving line drawings with references to a fully-detailed table of capacities and sizes. Instructions for selecting, fitting and working the governors are also given.

Drilling Machines.—The Henry and Wright Manufacturing Company, Hartford, Conn., U.S.A., send another catalogue of their Class B drilling machines. The series of machines range from one to eight-spindle types, all angle belt drive and ball bearings. Self-acting feeds and various table designs are well worked out and tapping and other attachments shown.

Steel Heat Treatment.—Automatic and Electric Furnaces, Limited, 6, Old Queen-street, S.W. 1, send three more 4-page leaflets dealing with the effect of quenching by water as compared with salt solution, the magnetic change point of iron and checking pyrometers, the use of salt baths in hardening. Useful practical information on all these branches of the subject is given very clearly.

Portable Electric Tools.—The consolidated Pneumatic Tool Company, Limited, Fraserburgh, and 107, Piccadilly, W. 1, send a special catalogue of their electrically-driven portable machines. Drilling, spike driving, hammering, grinding, coal boring, compressing machines are all shown and full details given of working capacities and suitable currents.

Heavy Machinery.—Messrs. Hugh Wood and Co., Limited, 65, Fenchurch-street, E.C. 3, send a small general catalogue of the Jeffrey Manufacturing Company's (U.S.A.) machines for which they are sole agents. Truck loading, elevating, conveying, crushing, coal cutting, &c., are illustrated and briefly described. A locomotive for haulage and a storage battery truck for running on rails, are also shown.

Rolling, Drawing and Shearing Machines.—Messrs. W. H. A. Robertson and Co., Limited, Bedford, send four pamphlet catalogues dealing with their rolling and kindred machines, of which they make a very large variety in full ranges of sizes. The rolling mills include sheet, bar, strip, groove, and coiling mills from fairly heavy to light patterns. The other catalogues show drawing machines for wire, rod and tube work; reeling and straightening machines; also shearing machines with straight and circular blades for a very wide range of work.

Water Purifying Plant.—Messrs. Tuke and Bell, Limited, 599, High-road, Tottenham, N. 17, issue two catalogues which show that they have given very searching attention to practical methods of treating sewage and other impure waters. Plants for 10-person country houses, hand carts with filtering apparatus for use in the fields of war or peace, laundry and hospital plants, are shown, suitable for various conditions. Concrete and steel tanks with all necessary metal and wood equipment are made in substantial and practical forms.

Steel and Iron.—The Partington Steel and Iron Company, Limited, Irlam, Manchester, have issued a well printed and bound pocket book catalogue containing much useful technical and commercial information in addition to a fine series of line drawings showing sections (mainly) of their products in ingots, billets, bars, flats, joists, channels, angles and rails. Section 12 (omitted from the index of sections) gives the diameters, wall thickness and weights in pounds per foot of cold drawn weldless steel tubes. The table on the next page gives the pipe threads per inch as 18 on both ¼-in. and ⅜ in., it should, of course, be 19. The book would be improved by a "Contents" table of the standard kind and a more complete index, for it contains much useful and valuable reference matter.

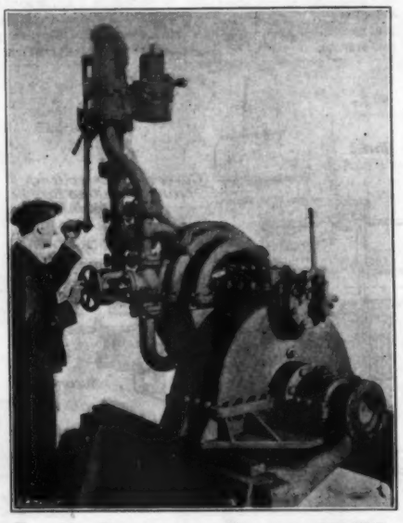


FIG. 22. TURBINE AND GEAR FOR 600 H.P. SUBMARINE CHASER.

Cutting Tools.—A case of handsomely-printed catalogues comes from Sir W. G. Armstrong, Whitworth and Co., Limited, Openshaw, Manchester, containing five sectional booklets dealing with twist drills, gauges, screwing apparatus, milling cutters and tool steel. While high-speed steel takes a prominent place, carbon steel maintains a hold for many purposes. Sizes, types, &c., of all small tools are fully stated in figures and illustrated profusely. Much practical information on the use, grinding and care of tools is given in clear language. The gist of it is much the same as of old; viz., keep your cutting edges sharp, grind to the correct shape and correct your feeds and speeds by the evidence to be read on the wear and tear of the tools. High-speed steel only reveals its wonderful powers under intelligent use. The intelligence of the workman is never superseded. These catalogues give striking proof of the advance of milling tools, including cutters, reamers and the small saws used on the milling machine, by the fact that half their bulk is in this one section.

Automatic Centre Lathe.—The Jones and Lamson Machine Company, U.S.A. (109, Queen Victoria-street, E.C. 4), send a book catalogue about their Fay automatic lathe. Unlike nearly all other "automatics," this lathe is only for work turned on centres, including mandrel work. There are two slide rests, each of which may carry quite half a dozen tools; for instance, the turning and crown-forming on four cone belt pulleys may be done at one tool setting, or the facing of the step sides at another. The lathe is fit for sliding, surfacing, taper, bevelling, recess and form turning; its automatic feeds being in both directions. Form turning is part of the work for which it is fitted, the tapering being done by a straight-line former, adjustable for different tapers. The book discusses and illustrates the classes of work suitable for the lathe without exaggerating its possibilities, and in a very informing style. The phrase "this is a real lathe with headstock, tailstock," &c., reads like a personal attack on the turret lathe, which has no tailstock; but, in fact, the usefulness of the turret lathe is fairly treated in the text. The makers advise that not more than two lathes be worked by a good operator to get the most economical results.

Water-Tube Boilers.—Messrs. John Thompson, Wolverhampton, send a catalogue of their water-tube boilers for land use, containing two excellent coloured illustrations and a large number of photogravures. The boilers are enclosed in a brick and metal housing, and consist of three banks, each bank having a water drum and a water and steam drum connected by straight tubes. The drums have shaped seats so that the tubes enter straight. A chain grate stoker is used and a superheater placed between the banks, so that one bank separates it from direct fire. Suspended from girders and supported below, the boiler is free to move under expansion without strain. The tubes are 3½ in. diameter, and number 18 per rank and 7 per file in each bank. The maximum heat impinges on the tubes and spreads over a large area. The drums are a very fine example of the boiler-makers' craft. It may be said also that the illustration of a drum on page 7 is a most creditable piece of engraver's workmanship. These boilers help to reassure us that the pre-eminence of British boiler-makers is not likely to be lost. Persumably we dare not say that a boiler can be beautiful, but in the illustration referred to something of that quality emerges from the studied design of the lines of flexible strength reduced to the utmost simplicity.

THE HOUSING PROBLEM.—The Design and Industries Association, of 6, Queen-square, W.C. 1, will hold a meeting to-day, January 17, to discuss the very urgent question of concrete in its relation to housing schemes and the like. The speakers will include Mr. F. Anthony White (chairman, Associated Portland Cement Manufacturers), Dr. Faber (consulting engineer), Mr. H. M. Fletcher (president, Architectural Association), Mr. C. H. B. Quennell (architect), and Mr. P. J. Waldram (engineer).

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Name, &c., of the Communicators are given in Italics.

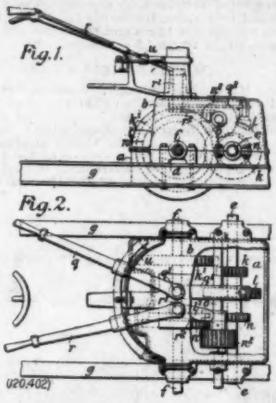
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

AGRICULTURAL APPLIANCES.

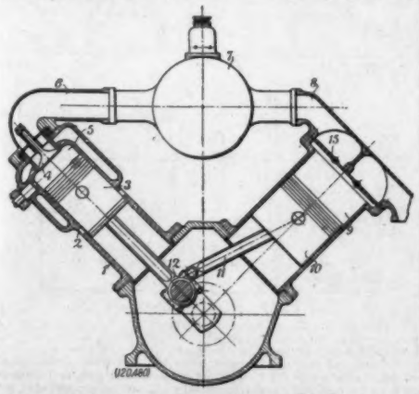
120,402. H. P. Saunderson, Bedford. Motor Tractors. (2 *Figs.*) April 23, 1917.—This invention relates to change-speed gear for motor tractors and, according thereto, the gearing with its box and the operating levers forms practically an independent unit which can be readily dismounted from the chassis. The lower and upper parts *a*, *b* of the gear-box carry the bearings for the first motion shaft *e* and the second motion shaft *f*. The blocks *d*, *d* which form the lower parts of the bearings for the shaft *f*, also constitute feet by means of which the gear-box is supported on the main frame *g* of the chassis and the bolts which secure the lower box part to the frame also serve to secure the two box-parts together; the bolts of the bearings for the shaft *e* also serve as connecting bolts between the two parts. *k*, *l* are the gears of a two-speed pinion which slides upon the first motion shaft *e*, and *k*1, *l*1 are speed wheels fixed upon the second motion shaft *f* and gearing with the



pinions *k*, *l*, respectively. *n*, *n*1 are pinions connected, respectively, to the pinions *k*, *l*, and *n*2 is a wheel of double width for reverse, carried upon a countershaft *o* and normally in an inoperative position. When the reverse motion is desired, the wheel *n*2 is engaged with the wheels *n*, *n*1. *q*, *r* are levers by means of which the gears for the forward movement and for the reverse are operated respectively, these levers being mounted upon the upper ends of spindles *q*1, *r*1. The spindle *q*1 has a lever *q*2 carrying a fork which straddles the wheel *l*, whilst the spindle *r*1 carries a lever *r*2 which engages with a lug on the countershaft *o*, so that the movement of the lever *q* can place the pinions *k*, *k*1, or *l*, *l*1 in engagement, according to the speed required, whilst the movement of the lever *r* can move the pinion *n*2 into simultaneous engagement with the wheels *n*, *n*1 for the reverse. The levers *q*, *r* are located on opposite sides of the steering wheel *t*. *u* is a quadrant having a series of notches corresponding with the several positions of the levers *q*, *r*. (*Accepted November* 20, 1918.)

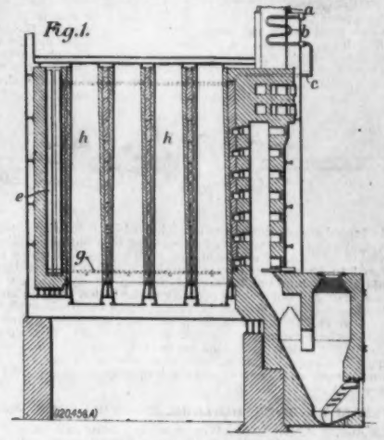
GAS ENGINES, PRODUCERS, AND HOLDERS, &c.

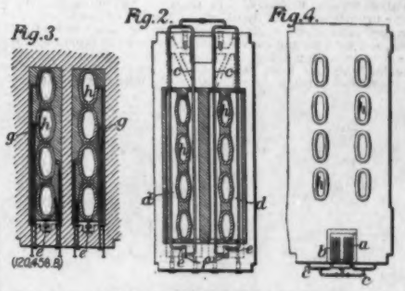
120,480. Boulton and Paul, Limited, Norwich, and J. D. North, Burgh Apton. Internal-Combustion Engines. (4 *Figs.*) December 29, 1917.—The invention refers to internal combustion engines of the two-cycle type and in which the fuel is injected into the combustion chamber of the lower cylinder. The engine has a power cylinder 1 of two-cycle type, having



exhaust ports 2 which are uncovered by the piston 3 at or near the end of the working stroke. In the cylinder head is an inlet valve 4 controlling communication between the combustion chamber 5 and a pipe 6 communicating with a reservoir 7 containing compressed air. The reservoir 7 is in communication by a pipe 8, with an air-pumping cylinder 9, the piston 10 of which is operated by a connecting rod 11 pivoted to the big end 12 of the piston rod of the piston 3 of the power cylinder 1. The intake and outlet valves in the head of the pumping cylinder 9 may consist of flexible plates 15. The operation of the engine is arranged so that when the piston 3 is at the end of its working stroke, air is admitted by the valve 4 from the reservoir 7 and flushes the power cylinder 1, driving the spent gases through the exhaust ports 2; when, therefore, the piston rises and closes the exhaust ports 2, the power cylinder contains a charge of pure air which is under pressure from the reservoir 7. It will be understood that at the moment of closure of the exhaust ports 2 by the piston 3, the valve 4 would be open and would remain open until the pressure in the cylinder was nearly equal to the pressure of air in the reservoir. The pressure air inlet valve 4 would then be closed and the charge would be further compressed by the rising of the piston. (*Accepted November* 20, 1918.)

120,458. S. Glover, St. Helens, J. West, Southport, and W. Wild, Blackpool. Retorts. (5 *Figs.*) November 20, 1917.—The invention relates to retorts for the continuous carbonisation of coal. There is provided at the base of the waste gas chimney *a* of the retort bed, a superheater *b* through which steam is passed under pressure. The steam then travels in pipes *c* through the waste gas circulating chambers *d* at the top of the setting and through ducts *e* in the division wall *f* in the vertical passage by which the products of combustion from the combustion chambers of the retort bed rise on their way to the waste gas circulating chambers *d* and the chimney *a*. The

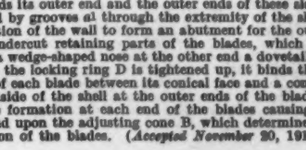




steam is thus highly superheated. It is then passed by the ducts *g* to the various retorts *h* and injected into the incandescent coke therein. The highly superheated steam issuing through the incandescent coke is converted into blue water gas without the extraction of a large quantity of heat from the contents of the retort, so that increased efficiency is obtained. The water gas passes into and through the central core or mass of partially carbonised and uncarbonised coal in the retorts and effects or expedites its carbonisation, carrying off with it the volatile hydrocarbons before they have been subjected to destructive distillation at very high temperatures. (*Accepted November* 20, 1918.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

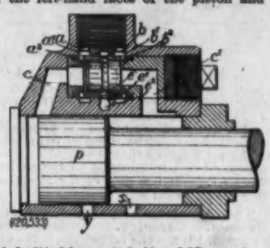
120,493. Vickers, Limited, Westminster, London, R. J. A. Pearson, Erith, and W. E. Power, Erith. Reamers and Taps. (2 *Figs.*) February 2, 1918.—This invention relates to reamers and taps of the type in which a set of cutting blades is adjustable radially in longitudinal slots in an outer shell by means of a central cone on which the inner faces of the blades bear, the blades being simultaneously locked in position by the aid of a locking ring with a conical face meeting corresponding engaging surfaces on the inner sides of the cutting blades. A is the shell of the reamer. B is the cone provided with an adjusting screw at its outer end and a screw-threaded stem at the other end. C, C, are the cutting blades. D is the



locking ring held in place by a nut on the screw-threaded stem of the cone B. The shell A is formed with a number of slots *a* towards its outer end and the outer ends of these slots are continued by grooves *a*1 through the extremity of the shell, leaving a portion of the wall to form an abutment for the outer ends of the undercut retaining parts of the blades, which parts form with a wedge-shaped nose at the other end a dovetail formation. When the locking ring D is tightened up, it binds the retaining part of each blade between its conical face and a conical face on the inside of the shell at the outer ends of the blade slots, the wedge formation at each end of the blades causing them also to bind upon the adjusting cone B, which determines the radial position of the blades. (*Accepted November* 20, 1918.)

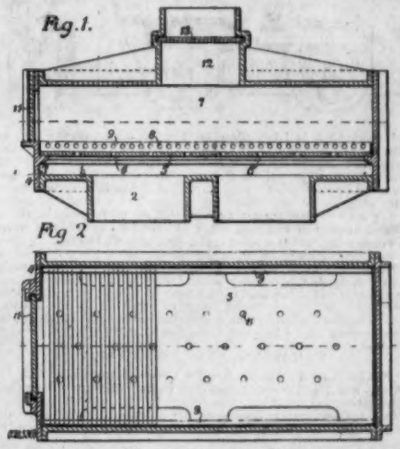
MINING, METALLURGY, AND METAL WORKING.

120,533. G. H. T. Rayner, Abbeydale, Sheffield. Rock Drills. (2 *Figs.*) July 23, 1918.—The invention relates to valve apparatus for rock drills and consists in a construction by which the valve is always thrown to one side or the other and cannot remain centrally placed, and in which the end of the valve which passes air to the piston for the forward stroke has a less effective area than that of the opposing end of the valve. Air is admitted at ports *a* and *b* and passes by annular grooves *a*1 and *b*1 and holes *a*2 and *b*2 to the valve chamber. In the construction shown, the left hand face of the valve is under pressure and the valve is held at the right hand end of the valve chamber, since the greater portion of the right-hand face of the valve is open to exhaust by the port *c*1, via the main cylinder through exhaust port *z*, in this cylinder wall. The live air passes into the port *c*, and thence to the left hand face of the main piston *p*, forcing the same to the right. When the exhaust port *y* is uncovered, the pressure on the left-hand faces of the piston and valve falls,



and the air (admitted by ports *b*, *b*1 and *b*2) pressing on the right-hand face of the valve, together with the air compressed in the cylinder after the exhaust port *z* is closed, forces the valve to the left. Air is then admitted to the right-hand side of the cylinder forcing the piston *p* to the left until the exhaust port *z* is uncovered, when the pressure falls and the valve returns to the position shown. It will be seen that the left-hand face of the valve has a less area than the right-hand face. It is obvious, therefore, that the valve cannot move into the position shown unless and until the port *z* is open to exhaust. If ports *y* and *z* are both closed when the machine is started, the valve must move to the left first, and cannot assume a central position; thus the machine must start. Provision is made by means of the annular groove *e*, port *e*1, and exhaust port *e*2 (communicating directly with the atmosphere) for any leakage air from the ends of the valve to escape freely to the atmosphere without exercising appreciable pressure in the space between the two collars of the valve. (*Accepted November* 20, 1918.)

120,530. P. Carlisle, Sheffield, and A. W. Harbord, Sheffield. Tempering Ovens or Furnaces. (2 *Figs.*) July 4, 1918.—This invention relates to tempering ovens or furnaces for use in conjunction with gas or solid fuel furnaces. The invention consists of an enclosed chamber having an inlet passage which conducts the heated gas to one side of a perforated distribution plate. Upon the other side of the plate is a grid, upon which the articles to be tempered can rest, and be heated by the gas passing through the perforations in the plate, a flue being provided to carry off the products of combustion. The

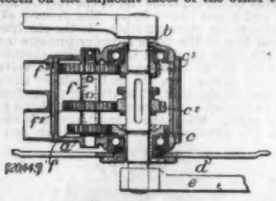


furnace has a baseplate 1 having two gas inlets 2. Resting on a ledge 3 on the walls 4 and a short distance above the baseplate, is a distribution plate 5 having holes 6 to allow the heated gas to pass through to a heating chamber 7. Above the plate 5, rods 8, which form a grill, are disposed transversely in the chamber 7 for the articles to rest upon. The ends of these rods are mounted in bars 9, which rest upon the plate 5. The heating chamber 7 is provided at one end with a sliding door 11. A flue 12 formed in the roof of the chamber 7, is fitted with a damper 13. (*Accepted November* 20, 1918.)

MOTOR ROAD VEHICLES.

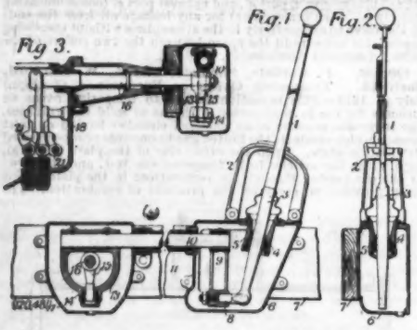
120,443. The New Hudson Cycle Company, Limited, Birmingham, T. S. Tisdell, Birmingham, and A. A. Price, Edgbaston, Birmingham. Variable-Speed Gear Mechanism. (3 *Figs.*) November 10, 1917.—The invention relates to variable-speed gear mechanism for cycles of the type in which the variable-speed gear mechanism is incorporated in the bottom bracket of the cycle frame. According to the present invention, gearing is mounted in a part adapted to be removed from and fixedly secured within the bottom bracket. This part advantageously comprises a box which is adapted to be inserted into the bracket and which is permanently closed at one end, and provided with a detachable plate at the other end. This box carries the crankshaft of the bicycle, and also a lay shaft, both of which shafts carry gear wheels adapted to be operated to give the different gears. In order to detach the gear-box, the chain wheel may be detached from the crankshaft, and the gear-box can then be withdrawn in an axial direction away from the chain wheel side of the bicycle. Inside the gear-box *a* the crankshaft *b* is encircled by three gear wheels *c*1, *c*2, *c*3. The two wheels *c*1, *c*3, are capable of rotation in relation to the crankshaft *b*. The wheel *c*2 is keyed to the crankshaft so that it can

slide axially thereon. The wheel c^1 has a sleevelike extension c^3 which passes through the permanent closure of the gear-box and externally carries the chain wheel *d*. The crankshaft extends beyond the chain wheel to carry the pedal crank *e*. The lay shaft is mounted between the integral closure web *a* of the gear-box *a* and the detachable plate a^1. The lay shaft carries three gear wheels f^1, f^2, f^3, combined to collectively rotate thereon. The wheel c^2 has dog-clutch teeth on each face arranged to be engaged with clutch teeth on the adjacent faces of the other two wheels



c^1, c^3. When the wheel c^1 is locked to the crankshaft the direct drive is obtained. When the wheel c^2 is in its mid position, the power is transmitted from the crankshaft *b* to the wheel f^2 on the lay shaft, and from the wheel f^1 to the wheel c^1 and chain wheel *d*. When the wheel c^2 is moved away from the wheel c^1 it locks the wheel c^3 to the crankshaft. The wheel c^3 is in mesh with the wheel f^3 upon the lay shaft so that the third or lowest speed is obtained, the power being transmitted to the chain wheel *d* in manner similar to that in the case of the intermediate speed (*Accepted November* 20, 1918.)

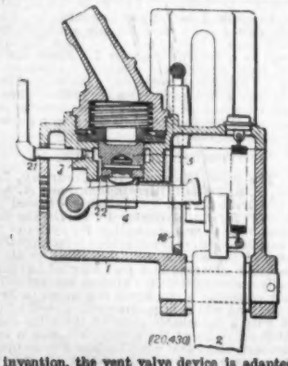
120,461. The Daimler Company, Limited, Coventry, and T. Dawson, Coventry. Change-Speed Gear. (3 *Figs.*) January 3, 1918.—The invention relates to controlling means for the change-speed gear of motor-driven vehicles. The change-speed lever 1, the movement of which is controlled by an ordinary gate sector 2, is formed with a cylindrical portion 3 passing freely through a ball trunnion 4 supported by a frame 5 contained in a ca-ing 6 attached to the frame 7 of the car; and at its lower end the change-speed lever 1 has an adjustable bolt 8 pivoted to it. The bolt 8 passes through, and is fixed in the end of a lever arm 9 keyed on the forward end of a rock shaft 10 extending parallel with and carried in bearings fixed to one of the longitudinal members 11 of the chassis, the rock shaft being capable of receiving either rocking movements about its axis or movements in the endwise direction thereof. Upon the rear end of the rock shaft 10 is fixed a lever arm 13 of loop formation



and carrying a ball trunnion 14 through which passes the end of an arm 15, keyed upon the selector shaft 16. The selector shaft 16 passes transversely of the length of the vehicle and enters the gear-box 18. The selector shaft 16 can have either endway motions or rocking motions. Through the medium of the selector shaft 16 the selector rods 21 are operated to control the motion of the gear in the usual way. It will be understood that the angular motion of the rock shaft 10 about its axis is the means by which a transverse motion in the direction of its axis is imparted to the selector shaft 16 when the change-speed lever 1 is moved through the gate of the quadrant 2. The rock shaft 10 is also as aforesaid capable of endway sliding motion in its bearings, and the act of striking the gear is obtained by a forward or backward motion of the change-speed lever 1, resulting in the endway motion of the rock shaft 10 and a partial rotary motion of the selector shaft 16. (*Accepted November* 20, 1918.)

RAILWAYS AND TRAMWAYS.

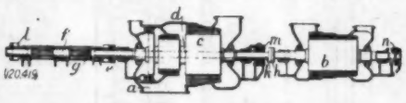
120,430. J. W. Cloud, King's Cross, London, and J. W. Cross, King's Cross, London. Fluid Pressure Braking Apparatus. (1 *Fig.*) November 7, 1917.—This invention relates to vent valve apparatus for operation solely by track apparatus not under the control of the driver. According to the



present invention, the vent valve device is adapted to control the flow of fluid from the train pipe into a partially or completely closed reservoir in the case of fluid pressure brakes or from a partially or completely closed reservoir into the train pipe in the case of vacuum brakes, so that a definite volume of fluid is permitted to escape from or be admitted to the train pipe when the vent valve device is operated. The port 7 is connected by a pipe 21 to a reservoir, not shown. A cavity 22 is adapted in the closed position of the valve 5 to establish communication between the port 7 and the interior of the casing 1, such cavity being so proportioned as to cut off entirely such communication in the open position of the valve. The operation of the device is as follows: When the arm 2 is moved out of its normal position by the projection located in the track and the pivoted lever 4 is allowed to fall by its own weight, the valve 5 is opened and communication between the interior of the train pipe and the receptacle is established through the port 7 and the pipe 21. The receptacle is of such proportions as to produce a reduction of pressure in the train pipe such as will produce a service application of the brakes. When the mechanism is reset by the device 16, the valve 5 is moved to its closed position and the lever 4 is again supported by the upper extremity of the arm 2 and the fluid under pressure entrapped in the reservoir connected to the pipe 21 is permitted to escape to the interior of the casing 1 through the cavity 22, from whence it passes to the atmosphere. It will be apparent that when the brakes are applied only sufficient reduction in the train pipe pressure is obtained to effect a service application of the brakes, the extent of the braking effort being, of course, dependent upon the size of the reservoir into which the train pipe fluid is vented. (*Accepted November* 20, 1918.)

SHIPS AND NAUTICAL APPLIANCES.

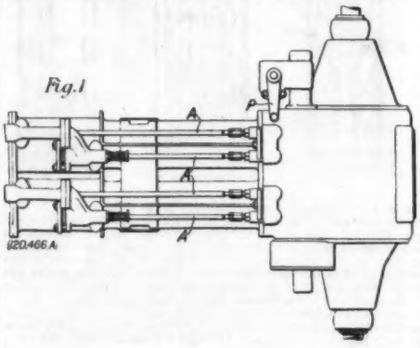
120,419. The Hon. Sir C. A. Parsons, Newcastle-on-Tyne, S. S. Cook, Newcastle-on-Tyne, and L. M. Douglas, Newcastle-on-Tyne. Geared Turbine Installations. (3 *Figs.*) November 5, 1917.—The invention relates to geared turbine installations for ship propulsion, and consists in placing the two turbines on the same side of the pinion shaft, the near turbine being connected to the near end of the pinion shaft, while the other turbine drives the opposite end of the pinion shaft through a small diameter intermediate shaft passing through central holes in the near turbine rotor and in the pinion shaft. Two turbines *a*, *b*, are provided co-axial with the pinion shaft

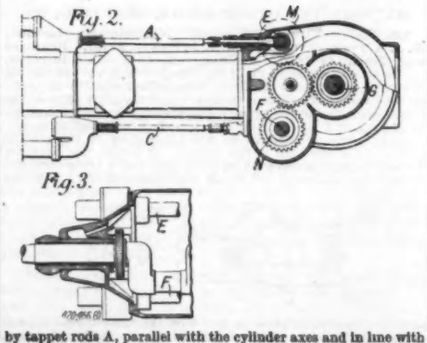


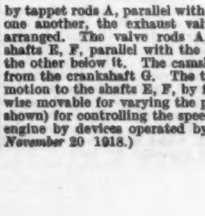
and situated at the same side of it. The turbine rotor *c* is mounted on a sleeve *d* and is adapted to be connected by a sliding coupling *e* to the hollow shaft *f* of the pinion *g*. The second turbine *b* is adapted to be connected by a suitable coupling *h* to an intermediate shaft *k* of small diameter passing axially through the hollow shaft *d* of the turbine rotor *c* and the hollow pinion shaft *f*, and connected at its far end by a coupling *l* to the hollow pinion shaft. By this arrangement the drive from the two turbines is taken to the two ends of the hollow pinion shaft. The central holes in the hollow rotor and pinion shafts are so bored as to support the central shaft at reasonable intervals along its axis. Thrust blocks *m*, *n*, and expansion couplings may be provided. (*Accepted November* 20, 1918.)

STEAM ENGINES, BOILERS, EVAPORATORS &c.

120,466. S. E. Alley, Westminster, London. Tappet-Valve Steam Engines. (4 *Figs.*) November 28, 1917.—The invention has for its object to provide in combination in a tappet-valve steam engine adapted for the propulsion of motor wagons, a simple and convenient arrangement of tappet-operating camshafts and gearing for driving them. In a two-cylinder engine, the four inlet valves are arranged above and the four exhaust valves below the cylinders. The inlet valves are operated

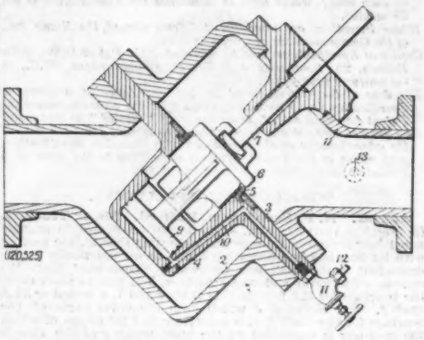






by tappet rods A, parallel with the cylinder axes and in line with one another, the exhaust valves by tappet rods C, similarly arranged. The valve rods A, C, are operated by two camshafts E, F, parallel with the crankshaft G, the one above and the other below it. The camshafts E, F, are driven by gearing from the crankshaft G. The timing wheels M, N, communicate motion to the shafts E, F, by feathers, and these shafts are endwise movable for varying the position of the cams on them (not shown) for controlling the speed and direction of rotation of the engine by devices operated by means of a lever P. (*Accepted November* 20 1918.)

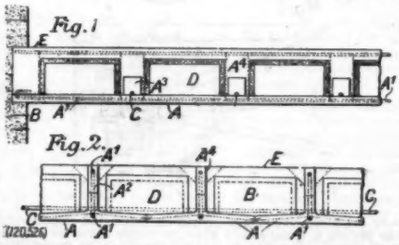
120,525. Babcock and Wilcox, Limited, London, and A. Spyer, London. Stop Valve. (1 *Fig.*) May 22, 1918.—This invention relates to a stop valve of the type comprising a case constituted by two parts having inclined adjoining ends and a partition formed with a valve seat between said parts. The adjacent faces of the case members 1 and 2 are formed with flanges between which, when bolted together, is interposed a partition 3 formed integral with a cylindrical casing 4 and fitted with a valve seat 5. Engageable with the valve seat 5 is the



valve proper 6, carried by the spindle 7. Connected to move with the valve proper 6 is the balance piston 9 fitted within the cylindrical casing 4, one side of the piston 9 being exposed to the pressure of fluid within the case member 2, and the space on the other side of the piston being in communication with a passageway 10 through the wall of the cylindrical casing and extending laterally through the partition 3, the flow through said passageway being controlled by a valve, the casing 11 of which is provided with a tubular connection 12 connectible to the boss 13 fitted to the case member 1. (*Accepted November* 20, 1918.)

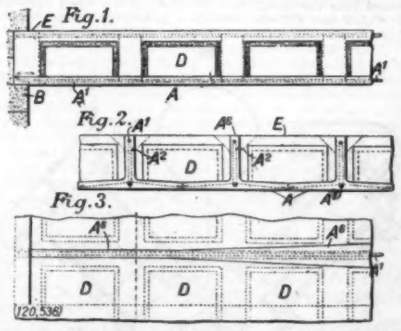
MISCELLANEOUS.

120,526. H. L. Barraclough, Westminster, London. Reinforced Concrete Floors. (3 *Figs.*) June 4, 1918.—According to this invention, the floor is constructed of a plurality of reinforced concrete inverted tee-shaped girders or beams laid in position with inverted pots, filler blocks, or other vessels to form voids, between them. The girders or beams A are cast at the works with reinforcing rods A^1, running through them, said rods being connected by bridles A^2 in the usual way. The



girders are also provided with apertures A^3 in their vertical webs or parts A^4. In constructing the floor, the girders or beams A are laid side by side on supports B and the floor reinforcing rods C are then passed transversely through the apertures A^3 in all the girders. Pots D to form voids are then equi-distantly placed between the girders and the floor-reinforcing rods C and concrete is then grouted in between the pots and girders and above the pots, and if necessary above the girders also, to make the floor E. (*Accepted November* 20, 1918.)

120,536. H. L. Barraclough, Westminster, London. Reinforced Concrete Floors. (3 *Figs.*) July 12, 1918.—According to this invention, the floor is constructed of a plurality of reinforced concrete inverted tee-shaped girders or beams, provided towards the centre with small flanges on the top of their webs and widening towards the centre, laid in position contiguously with a filling of concrete between the beams and with or without inverted pots, filler blocks, or other vessels to form voids between them. The girders A are cast at the works with reinforcing rods A1 running through them, said rods being connected by bridles A^2 in the usual way. In constructing the



floor, the girders A are laid close against each other side by side on supports B. Pots D to form voids (if used) are then placed subsequently between the girders over the joints at the meeting line of the feet or bases of the girders, thereby preventing the grout running through the saving waste. Concrete is then filled or cast in between the girders, or between the pots and girders and above the pots, and if necessary above the girders also, to make the floor E. The tops A^6 of the webs of the girders are made towards the centre with small flanges increasing in width towards the centre of the flooring, to take up the compression. (*Accepted November* 20, 1918.)